LEARNING FROM MUSEUM EXHIBITS: THE INFLUENCE OF SEQUENCE, VERBAL ABILITY, FIELD DEPENDENCE, AND PERSPECTIVE-TAKING INSTRUCTIONS

By

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The work published herein is dedicated to my wife, Georgeann A. Ellis, and to my parents, J. Frank Ellis and Dorothy A. Ellis.

"For the people, for education, for science"

Motto of the American Museum of Natural History, 1869

(Ramsey, 1938, p. 2)

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TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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Museums are unique settings where information, stimulation, and experiences are provided almost entirely through objects and their interpretative display. Visitors are expected to come away from a museum visit with an increase in their knowledge of objects and a change in their interest and motivation. Museum professionals, therefore, must not only understand, but mediate, the process of cognitive and affective growth from the museum experience.

The problems explored in this study are the extent to which exhibit sequence is important in the acquisition of cognitive and affective information in the exhibit; the extent to which visitor characteristics such as verbal ability, field dependence/independence, and general science

knowledge interact with learner acquisition of cognitive and affective exhibit outcomes; and the extent to which learners can be influenced by perspective-taking instructions given prior to visiting an exhibit. None of these questions has been explored previously in museums; therefore, related research is drawn upon from a variety of fields.

Regression analysis was performed with significant full model main effects for perspective and sequence on total score for the multiple choice recall measure ($F= 6.364$, $p<.05$). Further analysis indicated that giving perspective-taking instructions prior to viewing an exhibit produces significant positive effects on learning from an exhibit ($t= 3.196$, $p<.05$). This study also demonstrated that viewing an exhibit in a sequential manner significantly enhanced viewer learning from the exhibit ($t= 2.174$, $p<.05$). Findings also support previous research indicating that prior knowledge significantly enhances learning from exhibits, and that lack of such knowledge may hinder both attention to, and retention of, relevant knowledge from the exhibit. Evidence that visitor aptitudes interact differentially with a variety of conditions experienced during the viewing of the exhibit is reported and discussed. Strong evidence is presented for the development of exhibit adjuncts from which visitors with differing ability levels might choose in order to enhance the museum experience.

CHAPTER 1
INTRODUCTION

Museums and their role in the American educational and social process are described in a general sense by Soltis (1984), who stated,

> Education is a social process larger than pedagogy. It is carried out by all our socially constructed means for developing social beings, from schools and churches to museums and television, to boy scouts and sports. Whatever their primary functions all such institutions educate. (p. 9)

Garfield (1989, p. 100) quoted Cartwright (1939), who suggested that the "museum fulfills its social responsibility" by "inciting" the visitor through exhibits to return for further contact with the museum. Booth, Krockover, and Woods (1982) expanded on this by stating that a major purpose of museums is to awaken the visitors' interest as well as curiosity and to help them to develop some ideas on the subjects at hand. UNESCO (1986) also suggested that the major responsibility for museums is to broaden the rational basis of visitors' knowledge.

The idea of museums as part of the wide characterization of educational institutions that take "part in the shaping of human character" has been suggested by

Cremin (1977, p. 43) to have arisen in the 1780-1790s. Cremin (1977, 1980) further traced the rise of museums as well as botanical gardens from the early appearance of the Charles Willson Peale museum through the early 1800s. It was at this time that "museums, botanical gardens, agricultural fairs and circuses" were developing for what Cremin (1977, p. 48) suggests as various services to "science, art and entrepreneurship" and being "almost always educating." These historical educational links can be further traced to the 1836 legacy of James Smithson in his bequest to the Congress of the United States, which led to the founding of the Smithsonian Institution. His purpose was clearly stated--"the increase and diffusion of knowledge among men" (Rhees, 1901). By the 1930s museums began to see their central role as being in the area of adult education (Garfield, 1989). This focus shifted in the ensuing years to that of school groups and community education; however, it was not until the early 1980s that the focus began to shift to issues concerning aspects of museum learning (Jensen & Munley, 1985).

Museums are also unique settings where information, stimulation, and experiences are provided almost entirely through objects and their interpretative display. These museums must have their roots in their communities and understand the visitor's reality as it is actually experienced (Schouten, 1987). The fact that these

activities take place in such a setting puts museums at a very special crossroad of being able to mediate between research and general education (Wittlin, 1970).

Wittlin (1970) provided a direction or more appropriately an interpretation of education that museum professionals are only today beginning to rediscover. Education in a museum must be a process wide in scope, a "tuning" of people to their best ability to think and feel as well as to develop a wider understanding and appreciation for the phenomena found on this planet (Wittlin, 1970, p. 206). Schouten (1987) further stated that

> museum education has grown from being an activity of minor importance to an aspect of a museum's functions that cannot be overlooked. In most cases it has become, together with looking after the cultural heritage, the main justification for the museum's existence in the public's eyes. (p. 240)

Museums, therefore, can generally be assumed to be a place where learning and instruction, education, or enrichment are expected outcomes (Booth, Krockover & Woods, 1982; Falk, Koran, & Dierking, 1986; Grinder & McCoy, 1985; Koran & Koran, 1986a, 1986b; Melton, 1935; Screven, 1974a, 1974b). Equally, museums are not static natural phenomena in which exposure is thought to be enough to result in learning and motivation. Museums as opposed to classrooms are places where attendance is voluntary, where attending to individual exhibits involves free choice, where the learners are diverse in age as well as background, where content is not necessarily structured but may be variable, and where

the social aspects may be as important to the learning outcomes as the exhibits themselves (Koran & Shafer, 1982; McManus, 1988). Museum professionals therefore must come not only to understand but to mediate the process of cognitive and affective growth from the museum experience.

The generally accepted process for exhibit design by which the museum's "interpretive message" is formed has included the directors, curators, designers, and more recently the educators (Ambach, 1986; Jennings and Hansen 1987; Loomis, 1987; Shettel, 1988a, 1988b). This interpretive message is what in a majority of situations could be said to be at the heart of a museum's curriculum. This curriculum is considered to include goals, objectives in the form of learning outcomes, and a variety of presentation strategies (Beer, 1987). Visitors are expected to come away with an increased knowledge of the world beginning with facts about objects and hopefully leading to abstract ideas (Melton, 1935). Museum professionals, therefore, design exhibits and labels and use objects both to provide information and to introduce the museum visitor to what are deemed "important" concepts (Kropf, 1989). Interpretation is then a form of communication which needs to be perceived by the visitor (Roberts, 1989). A theoretical understanding of the relationships between an exhibit concept structure and visitor learning is needed.

Statement of the Problem

The problems explored in this study were as follows: (a) to what extent is exhibit sequence important in the acquisition of cognitive and affective material in the exhibit? (b) to what extent do visitor characteristics such as verbal ability, field dependence/independence, and general science knowledge interact with learner acquisition of cognitive and affective exhibit outcomes? and (c) to what extent can learners be influenced by perspective-taking instructions given prior to visiting an exhibit? None of these questions have been explored previously in the museum, therefore related research will be drawn upon from a variety of fields.

The objective of this study was to clarify what variables influence museum visitors when they are learning exhibit concepts and processing exhibit information. In particular, the objectives were (a) to ascertain differences in achievement resulting from variations in orienting information which establishes a perspective, given to visitors before the viewing of an exhibit, (b) to ascertain variations in achievement due to variations in the structure of exhibit content (a relationship is present between artifacts but must be inferred), (c) to ascertain variations in achievement due to variations in sequencing of exhibit content (there is a relationship among exhibit components that is evident and requires movement from a beginning point

to an end point), and (d) to investigate the relationship between visitor aptitudes--verbal ability, field dependence, sex and educational background--and exposure to exhibits containing structured and sequenced content.

Schwab (1974), in his discussion of educational curricula and instruction, defined structure in relationship to disciplines such as biology and physics. This approach would appear to encompass much of the work in museum exhibit design and interpretation. Structure can be viewed as "the body of imposed conceptions which define the investigated subject matter of that discipline and control its inquiries" (p. 166). This would appear to be in agreement with Briggs (1967), who defined structure in greater detail as meaning

> the description of the dependent and independent relationships among component competencies, arranged so as to imply when sequencing can be random or optional and when sequencing must be carefully planned, on the basis that transfer will be optimal in order to build up from simple skills to more complex ones. (p. 8)

Sequencing thus is implied within this definition to be an ordered or connected series of components that may or may not be required to achieve a particular outcome. Educationally, structure and sequence serve a number of purposes that include the design of instruction (Reigeluth, Merrill, & Bunderson, 1978). Formally, these design considerations include textbooks, courses, laboratory activities, etc.; whereas in museums, these considerations should encompass the designing of exhibits, adjunct

materials (brochures, orientation information, etc.), and other related activities such as discovery programs, guided tours, classes, etc.

Definition of Selected Terms

For the purpose of this study the following terms are defined in the following manner:

Aptitude. Any characteristic of the individual which facilitates, interferes, or acts selectively with learning (Cronbach & Snow, 1977; Koran and Koran, 1984).

Formal/Informal. Informal learning takes place in any setting outside of the traditional schoolroom. Formal learning takes place within the traditional school or classroom setting. This dichotomy is a forced one and should be seen as a continuum with formal and informal activities taking place in a wide range of settings including the museum as well as schools (Bitgood, 1988; Koran & Koran, 1988; Koran, & Shafer, 1982).

Learning. Learning has been defined as a "reorganization of the cognitive field", "a relatively stable, unspecified change due to experience", "a change in behavior", and that "cannot be accounted for in terms of instincts, maturation, etc." (Chance, 1979, p. 13, 17).

Museum. Museums are diverse institutions where objects are deposited/collected, stored, preserved, studied, and exhibited. They are centers of research and education (American Association of Museums, 1984; Webster's, 1988; Wittlin, 1970).

Perspective. The capacity to view things in their relative importance or the interrelation in which a subject or its parts are mentally viewed (Webster's, 1988). For instance, homebuyers view a home differently than the way burglars do (Anderson & Pichert, 1978; Anderson, Pichert, & Shirey, 1983). In this study a zoologist or geologist perspective was provided for subjects to use while viewing the Fossil Study Center.

Schema/Schemata. Abstract preexisting knowledge structures that individuals bring with them. Schema theory suggests that individuals bring with them mental representations that are used during perception and comprehension (Anderson, 1977, 1984; Anderson, Reynolds, Schallert, & Goetz, 1977; Milligan, 1979; Spiro and Tirre, 1980).

Sequence. A continuous or connected series (Webster's, 1988). Beginning at a basic level and progressively moving upward or towards some higher endpoint. Implies some form of hierarchy (Gagne, 1968, 1970, 1985; Mayer, 1977).

Importance of the Study

This study will provide insight into exhibit design based on what visitors need to know and do in order to learn from an exhibit. Historically, museum studies have been done in an effort to define or clarify who the visitor or user of museums and their exhibits is. There is also a common thread in most case studies--that of determining the educational value of the museum (Loomis, 1987). Miles (1986, p. 228) suggested that what is missing is an "analysis of what visitors need to know and do in order to learn" during their museum experience. Research has also been associated with a wide range of terms, including exhibit effectiveness, program accountability, and teaching and learning (Shettel, 1988a, 1988b; Statement of Goals, 1988; "The audience research", 1989b; Wolf, Andis, Tisdal, & Tymitz, 1979). In an attempt to define characteristics of ideal museum exhibits Alt and Shaw (1984) found that unless museum exhibits provide the visitor with a short, concise message, the exhibit will not attract the attention of the visitor. Winkel, Olsen, Wheeler, and Cohen (1975) in a study of visitor orienting media found that maps and signs and their combination were all effective in reducing disorientation in the museum with signs being the most effective in helping visitors. Signs in this case told visitors about the sequences of exhibits and helped the visitor find his/her way through the museum exhibits. Few

researchers have made any attempt to understand the underlying learning processes that are expected from the interaction of the visitor and the exhibit (Feher & Rice, 1985; Greenglass, 1986). In fact there is an underlying difficulty in the profession as a whole in that there is a lack of consensus as to what the basic aim and what the outcome of museum education is. Furthermore J.W. Marcellini, a zoo educator, has been quoted by Stapp (1987) as concurring with the general impression that the museum field in general is lacking a sufficient intellectual and theoretical base associated with other disciplines. In a Museum News (1989a) roundtable discussion on education, Carolyn Blackmon suggested that if museum professionals cannot define the museum's educational parameters, then there is not much of a starting point for future work. A major point of consensus, however, does appear in the area of concept learning, as a majority of the museum literature on exhibit design supports the idea that concepts form the basis of exhibits. Birney (1986), in studying the perceptions and knowledge acquisition of children from museum and zoo exhibits, suggested that "exhibits should contain concrete information from which abstract concepts can be developed" (p. 37). Litwak (1989, p. 58) acknowledged that advance organizers enhance the museum experience and raises the questions "how much information, located where and broken up how?". Therefore it is

imperative that in order to better understand the concept acquisition process in a museum setting, the interaction between the visitor and the underlying sequence and structure components of the process of concept learning needs to be analyzed. A theoretical base along with practical recommendations will provide not only an understanding of the learning process but also insights into how museums can become more effective in enhancing the learning process (Bloom & Mintz, 1990) and suggestions regarding how museums can optimize learning for a variety of visitors.

CHAPTER 2
LITERATURE REVIEW

The focus of this dissertation is on the interaction among sequencing of exhibit content, visitor aptitudes, and presentation of an orienting perspective to visitors in a museum setting. Therefore the literature cited will be that which either directly addresses the issue in a museum setting or has implications for the museum educator or designer. The structure of this review will be based on the framework proposed by Koran and Koran (1986a) for museum education research (see Figure 2-1). As museums are primarily places where objects and artifacts are exhibited, the review will begin with a review of the structure and sequence considerations used in museum exhibit design (Exhibit Characteristics). Exhibits are built under the assumption that visitors will view and interact with them, therefore Visitor Processing Activities, from both the cognitive psychology and museum research perspective, will be considered next. The literature review will conclude with reported findings on Museum Visitor Characteristics and

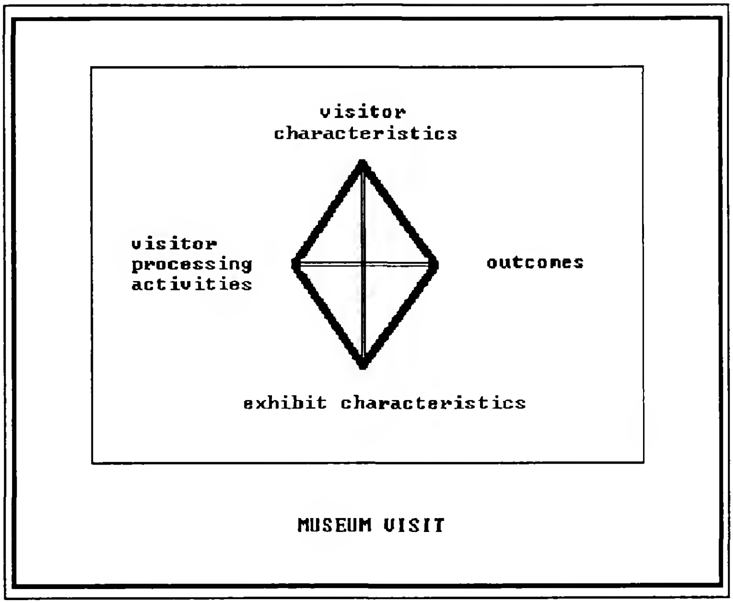

Figure 2-1. Museum Research Framework. Adapted from Bransford (1979) and Koran and Koran (1986a).

the Outcomes that are reported from the museum experience. On the basis of this review, research hypotheses for this study will then be formulated.

Exhibit Characteristics

Miles et al. (1988), in tracing the origins of the exhibit design tradition, highlighted the fact that as early as 1881 the tradition of objects being left to speak for themselves was clearly in place. Objects are the tools with which, as well as from which, the learning experience is constructed (Caston, 1989). In fact this tradition with the addition of "instructive-labels-and-well-selected-specimens" is perhaps the most common display found in museums today (Miles et al. 1988, p. 5). Low (1942, p. 45) suggested that this traditional approach to interpretation has been a "compromise between the duty felt toward scholarship and the realization that the public needs something different." An understanding of the effect of this compromise, however, has not been studied in any empirical sense. The fact that there is very little substantive information concerning the relationship between exhibit design and museum behavior and their influence on the visitor is well recognized (Lakota, 1975). Up until the early 1980s the study of museum educational work has been essentially that of a "common sense" or traditional approach. This common sense approach suggests that the object can best be used to present both ideas and concepts through their exhibition. Objects can

serve the purpose of informing the viewer, as well as clarify or reinforce the concepts or ideas being presented (Caston, 1989). The structure of this discourse at its most basic level is suggested to lie with the object for it is a "product of a chain of concepts--a need, an idea, a plan, a product" (Nye, 1981, p. 8). Taborsky (1990, pp. 58-61), however, questioned this approach in suggesting that the meaning imparted to or by an object can be arrived at in two ways. There is the "discursive interaction" whereby the meaning and information is created by the act of interacting directly with the object. The exhibit and/or object mediates the learning that takes place. The "observation paradigm" considers the meaning to exist in the object and to be impartially quantifiable. The visitor is expected to receive the information from the object in a linear intact way and any problems that arise are to be found in the viewer's knowledge structure. Taborsky (1990) recognized this as the traditional scientific approach. This is the traditional model still in use in many institutions today. Volkert (1991, p. 47), however, suggested that this "tradition" is changing to one of "public interaction with exhibits and collections." This transition from observation to discourse does not appear to significantly affect the fundamental concept that within exhibits, there must be some form of structure which should direct observations or about which dialogue is to take place. This is obvious in

Volkert's (1991, p. 48) statement about exhibit "core statements" or titles. Title or core statements "define with precision the organizing principles of the exhibition", "reflect the specific messages museums want to communicate to their visitors", and "are about relationships."

The logical sequencing and organizing of exhibits and objects into groupings with different themes, although appearing to be a recent concern and evolution, appeared as early as the 1930s (Miles et al., 1988). Structure and sequencing, although not explicit in the literature of that time period, is evident. Melton, Feldman, and Mason (1936, p. 3) raised what is perhaps one of the earliest questions about exhibit structure and sequence in stating that "the assumption that the visual presentation of objects and relationships is necessarily more effective than symbolic presentation through the written or spoken word has no scientific justification." They further questioned the relationship between the ideas found in the exhibit and the ideas that the visitor comes away with. "There is no pre-established harmony between the ideas which the exhibit illustrates for the scholar and the ideas it occasions in the untutored onlooker" (Melton, Feldman, & Mason, 1936, p. 3).

Melton (1935, 1972), in studying the relationship between visitors and objects in art galleries, found that objects considered to be of importance were not viewed by

the visitor when they were placed with a large number of other objects. Melton (1935) in his report on the decrease of interest over time during the visit suggested that this is potentially controllable through the use of structure or the "judicious arrangement of exhibits" so as to maximize heterogeneity throughout the museum. He identified the homogeneous nature of exhibits within a museum as cause for the rapid decline in interest as the visit progressed. More recently Caston (1989) and Wittlin (1970, p. 238) supported the latter concern with the structure of exhibits by suggesting that learning outcomes increased when fewer objects were used to present a "coherent story." Taborsky (1990) questioned this approach in suggesting that even the object within its context (as interpreted by the museum) is still not enough for it is the museum-mediated interaction with the visitor that is critical, which would supposedly include the number of objects/exhibits as a concern.

Taborsky's conclusion would seem to be supported by a 1975 study reported by Robert Lakota. He found that the way the subject and the content of a natural history museum exhibit are treated as well as the visitor's own subject matter knowledge are critical. Exhibits with a lot of texts and graphic panels have a negative influence on the visitor. In addition, if adults are accompanied by children, Lakota speculates that parents will not visit exhibits unless they already know the answers to potential questions from the

children. Therefore, it is the responsibility of the museum to provide the visitor with enough information with respect to content and organization on the exhibit so that the visitor can make an informed decision about attending to a particular exhibit. It is suggested that this information include not only the theme of the exhibit as well as the major objectives but also information that relates the exhibit to what the visitor already knows. Additionally, "if there is a rational organizational plan for an exhibit whether it is chronological, conceptual, or any other taxonomic scheme, the basis for that organization should be communicated directly to the visitor at the outset" (Lakota, 1975, p. 89). Lakota recognized as well that visitors who come to the museum may be either sequential or nonsequential learners. Although he recognized the importance of this characterization of the visitor, he recognizes the free choice environment of the museum in recommending that both groups need to be provided with the opportunity to know the order or structure of the exhibit. Lakota (1975) and Lakota and Kantner (1976) further recommended that this orienting information be provided at the entrance to the exhibit with reinforcement being provided throughout the display area. Earlier work by Winkel et al. (1975, p. vii) would also appear to be supported, that orienting media be located at what are called "major decision points" for the museum visitor. Although Lakota (1975, p. 93) reported that

conceptual orientation was of "marginal" importance when included along with other design variables such as exhibit size, density of cases, exhibit technique, and didactic techniques, both he and Lakota and Kantner (1976) suggested that it may benefit both types of learners referred to above. The importance of conceptual orientation may lie in the relationships that the exhibit presents and more importantly the linkages that it makes with contexts/objects in the visitor's world. Visitors are more likely to understand and relate to the exhibit thus demonstrating at the least an educated perception of the exhibit. In summarizing their research Lakota and Kantner (1976, p. 17) concluded that "exhibits which are most effective in holding visitor attention and promoting interaction are clearly organized conceptually and provide an explicit context for understanding the exhibit." They further encouraged the linking of concepts across galleries or exhibit halls to increase visitor interest in other areas of the museum. However, in keeping with other evidence that homogeneity tends to decrease interest, the authors recommend that unusual and unexpected content or exhibit treatment be included in order to attract as well as hold the visitor. Isaacs (1977, p. 40) goes further in concluding that too much structure can be "stultifying" and that "surprises within an orderly framework are vital." Further support for this idea is provided by Denning (1989), who reported that

the "discovery" aspects create a strong sense of excitement and interest in the visitors. Furthermore, in his evaluation of a computerized exhibit presentation he reports that "any program which disappoints or frustrates the user at the initial stages of the encounter runs the risk of leaving the user with a negative learning impression" and in the worst case "visitors blame themselves as the cause of the problems" (Denning, 1989, p. 11). All of these points are linked to the communicative effectiveness of the exhibit, which was found to increase based on whether visitors felt they understood the exhibit and learned from it.

These findings appear to be functionally useful as evidenced by Neal (1976), who, in an exhibits building handbook, described the use of the story board approach to exhibit planning. In her example the board consists of three columns. The first contains the written outline with major topics, followed by subtopics and general information. In the second column objects and comments about the objects are listed. Finally, in the third column the method of exhibit is described for each topic, subtopic, and object combination. This organization, although not described as such, offers a structured and sequential approach to the exhibit topic. Labels are also described in a structural and sequential format. Panels are suggested for the introduction of broad subject areas and sequences. Cases

display specific objects and illustrate topics based on their content. Case labels should then contain information on the "idea illustrated" within the case (Neal, 1976, p. 122). Labels must be concise and limited in quantity, and in the end the exhibit and labels combined must make the plan the designer had in mind immediately clear to the visitors. Additionally, the author recommends that exhibits not contain monotonous rows or crowded cases and that the designer remember that the visitor has a "definite range of physical and mental powers" that are frequently forgotten.

Miles (1986) furthered the development of an exhibit design theory based on sequence and structure by developing a series of assumptions upon which new exhibits at the British Museum (Natural History) were to be built. Among them is the recommendation that the "design process start with an analysis of what visitors need to know and do in order to learn rather than with a scholarly analysis of the subject matter" (Miles, 1986, p. 228). This and other assumptions, according to Miles, rejected the underlying behavioral objective approach which has been traditionally used in the process of exhibit design. Results of attempts to incorporate these recommendations appear to be mixed. Miles reported that the recommendation on designing exhibits based on how individuals come to know about specific subjects is a sound basis for exhibit development; yet the methodology to test these ideas more effectively may only

now become a reality due to the availability of microprocessors and related computers. With respect to objectives Miles (1986, p. 238) found that the greatest success lies in the clear statement and communication of what he calls "teaching points--the facts, concepts, relationships, procedures," etc., and how they relate to each other. The use of classical structuring based on learning hierarchies was found to be problematic as no exhibit could possibly include all of the needed components as identified by the concept hierarchies that were developed. The main idea of a structured approach, however, does remain a strong recommendation. The use of logico-dependency relationships as the main sequencing method remains at the basis of the suggested design theory. However, attempts to provide various levels of treatment appear to have failed. Miles reported that due to the inability of the designers to provide visitors with the appropriate and recognizable cues for the different demand levels of the "Enrichment Assemblies" of the exhibit, the decision was made to reduce the intellectual level of the entire exhibit to that of the main concept. The use of multilevel treatments according to Miles (1986, p. 239) "remains the biggest unsolved problem of exhibition design"; however, part of the solution is suggested. Miles reported on the success of their supplemental published materials (exhibit booklets). This work at the British Museum

provides the strongest evidence to date on the need for structure and sequence in exhibits. Little evidence, however, is provided on the process effects as well as interactions that may take place between the structured and sequenced exhibit and the visitor.

Miles et al. (1988), in reviewing the organization of the intellectual content of exhibits, highlighted the need for a better understanding of these processes. Learning is described as the process whereby individuals add new behaviors to their existing behavior repertoire. These added behaviors may then provide the researcher/designer with the evidence needed to be able to say that the visitor knows the intended information or object provided. Miles et al. went further in suggesting that, as often museums are concerned with the exhibitions based on concepts and processes, museum designers must be concerned with understanding as well. The need for structure and sequencing then becomes important in order to develop understanding. Prerequisites may exist that must be attended to in order for the individual to develop the appropriate linkages that form the basis of understanding. The demonstrated understanding then forms the basis of the expression of the organization of the individual's intellectual skills. Gagne (1970) and Miles et al. (1988) stated that structure facilitates learning; however, this structure in the museum setting serves both to provide the

visitor with a way to organize the information presented and to provide forward as well as rearward wayfinding directions through the exhibit. Although Miles et al. (1988, p. 51) suggested that the level of understanding achieved by the visitor is "entirely the visitor's own affair," they recommended, as Miles (1986) did, that designers should provide a variety of treatment levels organized around some central "spine" with the appropriate bridging links taking the visitor from level to level (see Figure 2-2). Structure then can be defined as the existence of some form of arrangement, organization, hierarchy, or pattern based on the character of the overall concept, object, or whole exhibit.

Sequence is not adequately described in the museum literature other than through inference when authors discuss objectives and structure. Miles et al. (1988), however, defined sequence to be the order that is used to present objects for viewing or the order in which activities take place. Although sequencing is not a major aspect of their study, Winkel et al. (1975, p. iv) in a study of orienting behavior at the Smithsonian's National Museum of History and Technology found that "most people could not tell whether they were entering an exhibit hall at its beginning"! Physical or layout problems, however, with respect to sequencing have been identified by Melton (1935), Lakota

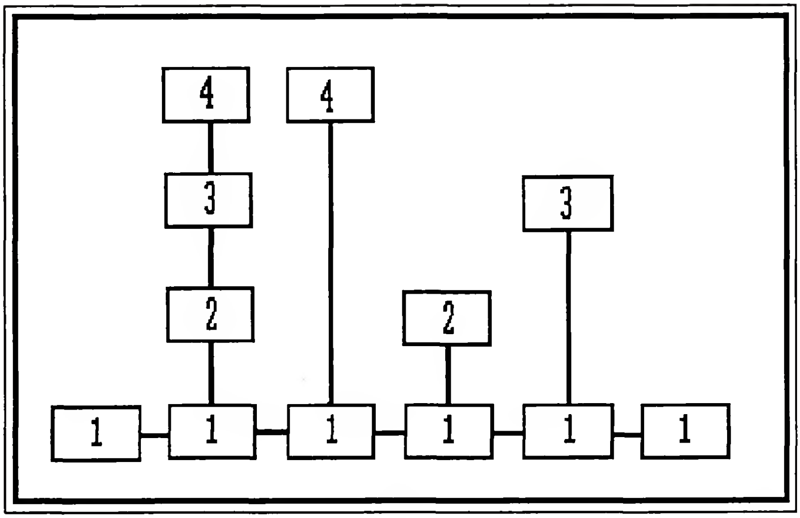

Figure 2-2. Levels of Exhibit Content. Adapted from Miles (1988).

(1975), Miles (1986), and Miles et al. (1988). Exits, movement patterns, other exhibits, orienting media, lighting, social activities, etc., all play a role in the effects of both the structure and the sequencing. If the fundamental design is inadequate and the visitor is unable to perceive the intended sequence and/or structure of the exhibit, the visitor may come away with an unintended message. Under these circumstances the visitor is likely to either attempt to organize the exhibited information on the basis of some existing knowledge base or walk away out of frustration and at the extreme with the feeling of internal inadequacy about himself or herself. Miles et al. (1988) recognized two structural forms of sequencing--conceptual or logical and topographical. The former is needed for the individual to be able to both connect and organize what is viewed as well as make the connection to his or her own knowledge structures. The latter is identified as forming the basis for being able to orient physically within the exhibit as well as for being able to link the parts of the exhibit across one another. The most characteristic forms of sequencing seen in science museums and natural history museums in particular include those based on chronological time periods (i.e. paleontology, fossil study centers, etc.) as well as those based on a particular taxonomy (i.e. hall of birds, mammals, etc.).

The learning process described above is assumed to take place in a sequential and hierarchical progression moving from the simpler prerequisite levels to the more complex (Gagne 1970, 1985; Gagne & Driscoll, 1988; Wilson & Koran, 1976). Furthermore Gagne (1985) and Gagne and Driscoll (1988) suggested a hierarchical structure for content of instruction. This form of content structure relies on the elaboration of concepts or subject matter to be presented which would include all supportive details and relationships necessary to acquire the concept.

Studies and recommendations such as those of Melton (1935), Melton, Feldman, and Mason (1936), Lakota (1975), Winkel et al. (1975), Lakota and Kantner (1976), and Neal (1976) have been important in clarifying the interaction between structure of the exhibit and the visitor. These studies also provide evidence that suggests the importance of organization, structure, or conceptual orientation in an exhibit. One can conclude that museum exhibits are most commonly designed with some form of structure and sequence in mind. This structure and sequence are also often based on the disciplines of the particular subject area being addressed by the museum or exhibit. It can also be hypothesized that it is easier to attend to more information if the visitor can find some means of organizing the information (Alt & Griggs, 1984). Research studies into the effectiveness of various teaching techniques on cognitive

outcomes both in education and in museums also provide an indication of the importance of structure in the learning process.

Visitor Processing Activities

Briggs (1967) in a comprehensive review of structure and sequence in education suggested that findings have been inconclusive or extremely experiment specific. In reviewing the literature he established eight categories as a basis for comparison within and across studies. In areas of maximum learner control (the highest degree of learner control) studies had not been of structure or sequence but rather on outcome only. Where there is learner controlled content and sequencing (learner is free to choose specific objectives and request information in sequence desired--which turns out to be different than that designed), no empirical studies were done. He suggested that, for adults, if given well stated objectives and availability to sources of relevant information, they might well achieve the objectives more efficiently. In the case of learner selection of materials and procedures (materials limited and packaged into specific groupings) one must provide the learner with a broad outline of the competencies to be achieved and a suggested order in which to achieve them. More positive results appear in the area of mixed experimenter and learner control (what Briggs called adjunct

auto-instruction) where the sources of information are fixed such as textbooks, lecture, etc. Here adjunct questions resulted in better learning than instructional conditions that do not employ consistent and immediate feedback--student can go back and review in whatever sequence. In fact his conclusion that "the task of discovering how to sequence the text in a way meaningful to the student may be so difficult that it is better to use texts as they are with adjunct methods" may be most relevant to museums in that exhibits may be as difficult to structure and sequence (Briggs, 1969, p. 39). For studies where the experimenter determined sequencing of instruction based on hierarchies of competence (subordinate and superordinate competencies in a logically derived hierarchical structure--principally the work of Gagne) the arrangement of competencies in the order in which they need to be acquired was empirically supported. In the case of experimenter determined sequencing of frames in programmed instruction (often logical versus scrambled studies) changes in any one frame were likely to interact with other aspects and characteristics of the program. Results, however, on inductive versus deductive sequencing in this category suggested that deductive was generally found to be superior to the inductive especially for immediate retention with the hypothesis that inductive sequencing may be better for longterm retention. Briggs concluded his review with learner determined branching in

auto-instruction (out of sequence based on learner readiness or performance on objectives) for which little empirical work existed and experimenter prepared advanced organizers for which evidence suggested that providing a conceptual framework facilitated learning of the materials in the lesson itself. Other reviews of structure and sequencing by Reigeluth, Merrill, and Bunderson (1978), and Patten, Chao, and Reigeluth (1986, p. 464) are best summarized by the latter who concluded that an awareness of both structure and sequence is important in providing the individual with the context of the information to be attended to thus resulting in what they call a "more densely packed and longer learning episode...without fatigue." Briggs concluded that the overriding concern for structure and sequencing has been one of instructional design rather than an actual empirical test of the effects of as well as interactions between structure and sequence. Cognitive psychology on the other hand, has begun to deal with the processes that are involved in learning and offers a number of areas of inquiry for the museum professional.

<u>Sequence Implications for Museums from Cognitive Psychology</u>

Museum research has for many years focused on the behaviors of the visitors that can be modified through either changes in the exhibits themselves or changes in the physical layout of the museum (Lakota, 1975; Melton, 1935; Miles et al., 1988). This approach to influence the

behavior of visitors best matches the behavioral conception of learning that focuses on changes in the environment to influence learning. The emphasis of this dissertation, however, will be on the cognitive conception of learning which focuses on changing the learner or encouraging the learner to use appropriate learning strategies (Shuell, 1986). The latter focuses more on structured knowledge rather than behaviors and on feedback strategies rather than reinforcement. Emphasis is on mental processes and knowledge structures as well as meaning and understanding. This appears to be congruent with the directions for museum exhibit design as discussed above and for museum research into visitor activities (Koran & Koran, 1986; Lakota, 1976; Miles et al. 1988).

Lakota (1976), on the basis of a review of cognitive psychology literature related to education in museum, concluded (a) that museum visitors can learn simply by being told to learn (based on Ausubel, 1963, 1968; Carroll, 1968; Postman & Senders, 1946); (b) that if museum visitors have no apparent logical structure upon which to organize information they will spend most of their already limited time attempting to organize the exhibit themselves (based on Meyers, Pezdek, & Coulson, 1973); (c) that retention and recall of exhibit information will increase given a knowledge of exhibit organization (based on Meyers, Pezdek, & Coulson, 1973); (d) that for exhibits of high technical

content and low subject familiarity to visitors, organizational information is critically important (based on Dyer & Kulhavry, 1973, and Tobias & Duchastel, 1972); and (e) that museums should tell visitors about concepts and direct visitors to "find" objects, groups of objects, specific characteristics about objects, etc. (based on Anderson, 1970; Bloomberg, 1929; Powell, 1944). Lakota in his 1976 study of learning support systems reported finding that pretesting and instructions to learn combined with maps with sequential information on the exhibit layout, questions before and after the exhibit, and a directive-sequenced audio tape adjunct to an exhibit were all effective over the pretesting, instructions to learn and exhibit only condition in producing learning support (cognitively as well as affectively). Lakota also concluded that as his subjects were "highly skilled" (89% had a college education) they were capable of benefiting from the systems tested whereas he surmises that those without this skill may not benefit. The implications being that the treatments required a generally higher ability level than might be expected to be found in the average visitor and that other forms of cognitive support must be found that will allow a wider range of visitors to make the needed linkages between their knowledge structures and those contained in the exhibits.

Koran and Koran (1986), in their proposed framework for museum research, included as one of the critical components

consideration of visitor processing and orienting activities. Koran, Koran, and Foster (1989), in a review of cognitive psychology research, offered the following processing as well as orienting recommendations. Based on the work of Salomon (1983), information handouts should be provided to visitors that describe the complexity of the exhibited relationships and concepts. Research has suggested that the amount of mental energy that an individual invests in a particular activity based on whether a task is perceived as being hard or easy significantly impacts what is learned. Visitors who are informed about the structure and sequence within an exhibit may therefore invest greater energy than if they perceived it as having no real structure or sequence. Salomons's work is clearly linked as well to the work of Anderson, Pichert, and Shirey (1983) who reported that what is learned is linked to the perspective that a learner takes. Koran, Koran, and Foster (1989) recommended that labelling or other adjunct materials be provided to the visitor so that they might take a perspective while viewing an exhibit. If the visitor could pretend to be an explorer or a paleontologist and could be provided with directional instructions to identify or investigate a particular aspect of the exhibit, outcome might be enhanced. Visitors could follow a structured or sequential investigative path that might or might not be inherent within the exhibit. These recommendations of

providing the visitor with ways of analyzing or viewing the exhibit are supported by the work of Brown, Campione, and Day (1981). These authors suggested that when individuals are provided with the knowledge of how to consciously monitor and use learning strategies, the learning outcome will be enhanced. Based on this work it would appear that providing visitors with strategies on how to view exhibits should increase their learning outcome as well. This is, however, dependent on the fact that the exhibited objects and accompanying information have been analyzed so that rules, structure, and sequences built in can be followed by the visitor.

Koran, Longino, and Shafer (1983), based on the work of Bransford (1979), Gagne (1970), and Keele (1973), also described an information processing framework for the study of learning in museums (see Figure 2-3). Gagne and Driscoll (1988) enhanced this framework (see Figure 2-4) by incorporating the broader theories of intelligence such as those of Sternberg (1979, 1985a, 1985b)--componential structures-- and Atkinson and Shiffrin (1968)--control processes. As can be seen these theories carry with them an implication of a systematic and structured flow of information. Therefore, information processing components are of importance due to their potential to both provide information on how a visitor thinks and to provide directions for influencing this process. An understanding

```
           Stimulus
              ↓
              ↓
              ↓
  Attention, perceiving
       and coding
              ↓
              ↓
              ↓
       Short term
         memory     ↔ ↔ ↔  working memory
              ↓               ↑↓
              ↓               ↑↓
              ↓               ↑↓
       Long term              ↑↓
         memory  ↔ ↔ ↔ ↔ ↔ ↔
              ↓
              ↓
              ↓
       Retrieval
              ↓
              ↓
              ↓

       Response (performance)
```

Figure 2-3. Information Processing Framework. Adapted from Koran, Shafer, and Longino (1983) and Gagne (1985).

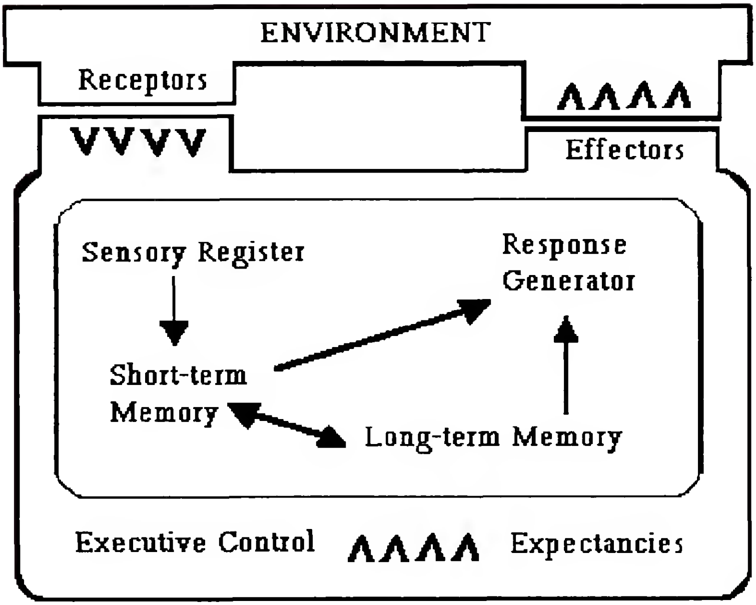

Figure 2-4. Enhanced Information Processing Framework. Adapted from Gagne and Driscoll (1988).

of these processing components can provide the museum exhibit designer with insights into how exhibits can be developed that are adapted to individual differences (Koran, Koran, & Foster, 1989). In instructional design the learner is held responsible for attending to the instruction and for actively constructing the mental elaborations needed to understand the information (Wittrock, 1978). Furthermore, according to Wittrock (1978), the instructor is responsible for developing and carrying out activities and interactions that help in this construction and elaboration process. From this it can be inferred that the museum exhibit designer is responsible for providing the visitor with adequate cues and structures that will allow the visitor to access his or her own mental or cognitive processes using existing strategies, knowledge, memory structures, etc. Behaviors that mediate between the learner and the exhibit or instructional activity and lead to the acquisition of or change in learner or visitor knowledge have been coined as "mathemagenic behaviors" (Rothkopf, 1970, p. 325). Such behavior include orienting, attending, encoding, reviewing, categorizing, elaborating, etc. Methods of affecting these behaviors include cuing strategies, questions, directions, incentives, and advance organizers (Frase, 1970; Mayer, 1979; Rothkopf, 1970; Wilson & Koran, 1976). Depending on the type of questions and positioning, they can have the effect of both forward shaping as well as rearward review.

Orienting information can serve to aid the learner in making the appropriate connections to prior information, existing information, and to the flow of the activity as demonstrated by Ausubel and Fitzgerald (1962). Mayer (1979) reported that of three different theories related to organizer effects on learning, the Assimilation Encoding Theory had the strongest empirical support. In this process new information is actively integrated with existing knowledge producing a broader learning outcome. Questions in museum labels have been reported to increase visitor reading time and related activities adjacent to the label; however, if the focus of the effort is to be the learning of concepts, rules, or other generalizations, little evidence has been presented (Hirschi & Screven, 1988). Rothkopf (1970) and Wilson and Koran (1976) also highlighted the difficulty of distinguishing between the actual stimulus or object presented to the learner or visitor and what they call the "effective" stimulus or object that is actually encoded. It is the behaviors of the learner during and subsequent to exposure to the learning situation that modify, transform, or further elaborate on the original stimulus and create the effective stimulus. Additionally, Wilson and Koran (1976) reported that there is an implied structure in the methods used to affect these behaviors and that structure in learning research has been shown to be a necessary aspect for those students of low as well as average ability.

Higher ability students on the other hand benefit less from structure instruction and more from self-direction and what Cronbach and Snow (1977, p. 504) referred to as "intellectual adaptation."

Aptitude treatment interaction studies also provide supporting evidence of the nature of structure and sequences and their effects on individuals. For the purpose of this paper aptitudes are defined as any characteristic of the individual that functions selectively either facilitating or interfering with learning from a particular instructional or exhibit method (Cronbach & Snow, 1977; Koran & Koran, 1984). Cronbach and Snow (1977) in their review of individual differences and instructional methods found a combination of widely divergent as well as convergent research results that are suggestive of a relationship between structure and individual aptitudes. They reported, however, that in many cases research results are contradictory and in fact may be context dependent, thus ruling out generalizations as well as comparisons. Results that are suggestive of interactions between structure and individual differences are as follows:

> Learning strategies. The multiple hypothesis method works best for high ability individuals whereas a single hypothesis works best with low ability individuals. The strategy to be taught depends on ability level.

Advance organizers. Advance organizers serve to facilitate learning in subjects of low verbal ability or low prior knowledge. Under certain conditions, however, high ability individuals did better with an advance schema whereas low ability individuals did better without the schema. Comparative organizers benefit low ability individuals. Organizers in general produce better results for low ability students than do pretests. Constructed responses without familiarization are better for highs and constructed response plus familiarization is better for lows.

Questions. Although results are mixed, questions after text are reported as being better for high ability individuals and questions before text are better for those of low ability. Questions appear to be overall better for all.

Inductive/deductive/discovery learning. Inductive methods are better for high ability whereas deductive is better for low ability individuals. Discovery learning appears to be disadvantageous for low and not harmful for high and medium ability individuals.

Reasoning ability. Individuals with low reasoning ability do better with added structure.

Conceptual level. Low CL individuals do better with external direction or directed teaching. High CL do better with greater control of situations.

Conceptual styles. High analytical ability students learned analytical concepts faster than inferential and relational concepts with lows being the opposite.

Programmed instruction. Overall measures of general aptitudes predicted outcomes. Initial scores were correlated with outcome scores from PI. Gagne's work that suggests that programmed instruction can carry a person past predictions based on their entering aptitudes is not proven. Some results did indicate that based on achievement as an outcome, abler students did better on scrambled versions and less-able better on orderly versions. Attitude appeared to be more positive for the abler students on the orderly version with less positive attitude on the scrambled. In general findings appeared to be at best context and program specific making generalizations difficult.

The aptitude treatment interactions (ATI) suggested by the research described by Cronbach and Snow (1977) support the idea that "there is no one best educational treatment or environment (exhibit) suited to some general, average individual, but that different individuals thrive in different environments suited to their own characteristic needs" (Koran & Koran, 1984, p. 795). It can be hypothesized that structure and sequence provide the learner/visitor with what Ausubel and Fitzgerald (1962, p. 243) called "ideational anchorage." In addition knowledge

of the structure and sequence of the material to be studied or viewed is necessary for linkage as well as subsequent learning. Mayer's (1979) work also suggests that the importance of advance organizers appears to lie in its affect on transfer as he found the strongest positive effects not on measures of retention but on those of transfer. Thus a visitor, given the appropriate structure and sequencing information on one exhibit, may have carryover to other similarly structured and sequenced exhibits. The aptitude treatment interaction research also provides a foundation upon which it can be surmised that different individual characteristics will mediate the learning process either negatively, neutrally, or positively. These characteristics of the visitor will be reviewed in the visitor characteristics section.

Sequence Implications from Museum-Based Learning Research

There is an ongoing debate in the museum field as to whether and when learning takes place, how it occurs, under what conditions, and the outcomes that might be indicators of this learning. Researchers such as Screven (1969) and Shettel (1973) have entered the debate by taking the position that the museum provides a valuable opportunity to provide visitors with experiences that can increase their knowledge and affect their beliefs and attitudes toward many subjects, ideas, etc. Screven (1969) suggested that it would be of value therefore to find ways of enhancing the

museum experience to make it a better learning experience. This position then is consistent with the aim of attempting to discern the effects of sequence on the learning process in the museum. Winkel et al. (1975) provided support for this conclusion by reporting that even when visitors are provided with a combination of orienting media (maps and signs) 40% of the visitors still felt that they needed more orienting information, brochures being the most commonly mentioned solution. Again as stated in reviewing the design considerations of structure and sequence, there are relatively few direct references to either structure or sequence in the museum based research literature. As a number of researchers have been interested in the prescriptive approach or providing teaching aids or added support for visitors, it will become apparent that structure and sequence are indeed important elements.

Some of the earliest studies suggesting the importance of structure and sequence are reported by Ramsey (1938). Ramsey reported on a study by Gibson (1925) in an art museum in 1923-24 that looked at the effect of a museum lesson and presentation that gave fifth grade students background information needed to answer a set of questions related to the museum exhibit. Prior to the study students were tested to determine their ability levels. Results from the post-tests and retention tests indicated that low ability students benefitted the most from this approach. Although

not identified with advance organizers this study appears to be one of the earliest museum based studies of this idea.

Ramsey (1938) also reported on an art museum study in 1924-25 by Marguerite Bloomberg (1929) on the effects of different lesson plans on student outcomes from a museum visit. Using a similar high, average, and low ability classification for students the results indicated that out of nine plans used, high ability students achieved best when they were given a classroom presentation about their visit by museum staff one day prior to the visit. Low ability students were reported to have done best when they were provided with a list of questions when they entered the exhibit area. The author, however, reported that the plan for which the students showed the most enthusiasm was also the one in which both high and low ability students performed the worst. This plan allowed the students to follow their own interests and view the exhibits as presented much as visitors do to this date. Ramsey also suggested that the results of this study indicate the value of less teacher-centered instruction and more investigation on the part of the children.

Melton, Feldman, and Mason (1936) in a study of over 2,500 fifth and sixth grade students found that preparing students for a museum visit is most effective when it occurs one day before the visit rather than two days, one week, or two weeks before. Formal lectures as part of the museum

visit were found to be equally effective for the students at either the beginning or end of the visit on the condition that the lecture take place in the exhibit hall. When looking at the effectiveness of three different methods of instruction (illustrated lecture, question cards, and discussion) across 5th, 6th, 7th and 8th graders Melton, Feldman, and Mason (1936) found the differences in outcome to be a function of educational level or the subject matter being studied. No single method appeared to be better; rather some methods were better for younger students than older students and these differences varied depending on the subject matter of the exhibit.

Abler (1968), in the first and only reported effort to study the effect of the order in which material was viewed in a museum, failed to find significant results due to methodological problems, predominantly because of a lack of randomization and adequate experimental controls. This study, however, is important for the implications for further study that result from the data collected. Abler hypothesized that learning was the result of the combination of visitor traffic patterns and the organization of the materials within exhibit cases. The basis for this hypothesis was the consistently reported visitor behavior pattern of turning right upon entering an exhibit hall and the fact that exhibit design is based on visitors reading left to right as in printed media (books, newspapers, etc.)

(Abler, 1968; de Borhegyi, 1968; Dorr Dennis, pers. comm., 1991; Kearns, 1940; Melton, 1935; Porter, 1938; Weiss & Boutourline, 1963; Yoshioka, 1942). In this study the contents of the exhibit case depicted a sequence of activities or steps in the production of an object (i.e., procedural structure--Riegluth, Merrill, & Bunderson, 1978). Four sequenced "blocks" (panels?) were used that could be readily ordered. In the first half of the study visitors approached the case from the left and viewed the blocks either in sequence or in reverse (A -> 1,2,3,4 or B -> 4,3,2,1). For the second half of the study visitors approached the exhibit from the right and viewed the blocks in order reading from right to left (4,3,2,1 <- C.) or approaching again from the right however viewing the blocks in reverse, again reading right to left (1,2,3,4 <- D). Unfortunately a number of participants were pre-cued that they would be taking a post-test thus affecting scores on an already non-randomized study. Overall outcome scores indicated that learning took place for those approaching from the left and viewing in sequence (A) as well as in reverse order (D). This effect disappeared however when the results of those who were cued to the testing were removed from the analysis. In addition, Abler attempted to discern viewer opinion about the exhibit being viewed; however again, methodological problems made interpretation of the data impossible. Although the number of subjects was low

for the entire study and the methodology was less than desirable, the results of this study do provide an interesting result that is supported by research in museum studies as well as education in general. Visitors who were cued in advance about the testing apparently were able to overcome the sequencing reversals and score on the average higher on the post-test, thus affecting the overall interpretation of the results! Design of the experimental case appears to have been well considered; however, as no information on visitor characteristics such as age, educational background, etc. were provided, interpretation of the results is difficult, or at least tentative.

Screven (1968, 1969) recognized early on that even the best designed exhibit is limited in its ability to communicate with the visitor. This he attributed to the characteristics of the museum visitor that include the heterogeneity of the population, voluntary attendance, free choice environment, and the fixed nature of the exhibits. In particular, Screven (1969, p. 8) stated that "it is difficult to control the order with which the visitor will view materials where simple ideas must precede complex ones." These points are important due to the fact that learning is often defined in conjunction with education or learning in the more formal sense of the school, the classroom in particular. In the formal sense the classroom would tend to have homogeneity in the sense of student age,

ability, etc., involuntary attendance, teacher structured choice, and teacher varied presentation of the materials as well as interactions. Furthermore Screven recognizes at the outset that as in the exhibit design process, specific objectives or expected effects on the visitors are needed at the outset and these are essential for the evaluation process. These ideas form the basis of Screven's research with the chief goal as "the design of a learning system which allows the visitor to interact with and be directed through the exhibit in such a way that learning occurs and the instructional objective of the exhibit is achieved" (Screven, 1969, p. 170). The design of this research was based on the use of programmed questions that provided the visitor with exhibit concepts and "relations proceeding from simpler to more complex concepts" (Screven, 1969, p. 170). A series of audio and programmed card aids that worked in conjunction with a specifically adapted exhibit were found to produce significantly more learning in visitors that used them (Screven, 1974). Varying degrees of feedback were provided to the treatment groups thus increasing the interactive nature of the activities. Overall Screven found that when visitors had no guiding aids, no pre-exhibit test or other knowledge of what they were expected to get from the exhibit, learning did not take place to any significant degree. These results suggest that Screven's original hypotheses about the functions of aids such as self-paced

audio may be correct. These aids may serve to "direct attention to relevant exhibit information and control the order or sequence in which different exhibit components are viewed" by relating exhibit concepts to each other and/or filling in missing information. Screven (1975, p. 219) reiterated the concerns expressed by Miles (1988) with respect to multilevel design in stating that the adapting of exhibit techniques to meet the needs of the heterogenous museum visitor is "one of the most important challenges of public museums." This challenge can be met not only by better exhibit design considerations but also by providing adjuncts to exhibits such as programmed instructional aids.

DeWaard et al. (1974) continued with this line of research through the use of programmed cards. In this study the cards contained varying degrees of information from low-program questions only to high-with supplementary information that directed attention to aspects of the exhibit. Overall the visitors using the learning program had higher post-test outcomes than those visitors who took the post-test only or those who visited only the exhibit and then took the post-test. An interesting collateral result, a finding that was also reported by Screven (1974), is that these types of programs were used by a limited range of visitors with adults being under-represented. Screven (1975) in another study of labels and adjunct devices found a combined effect that was rather larger--labels plus

adjunct systems. Labels along with the objects were found to produce relatively low levels of learning. More surprising question labels used in the study had no effect over that of the informational labels in improving learning. As in all museum research the results are probably a function of a combination of situation specific problems. Question type, information, format, exhibit content, exhibits physical structure, etc. are but a few of the possible problem areas that affected this study.

The study of the impact of novel settings on field trips provides some of the strongest evidence regarding the effects of structure and sequence in a museum setting. Falk, Martin, and Balling (1978) found that 10-13 year old students unfamiliar with a particular field trip setting when compared to those already familiar with the same setting did not benefit from the structured educational activity presented. Unfamiliar students spent much of their time in setting oriented activities whereas surprisingly the familiar group was able to do both the setting as well as the conceptual related learning simultaneously. Balling and Falk (1979), in a review of four studies on the effects of setting on field trip outcomes, report that although there is a setting novelty effect, significant cognitive learning does occur on field trips especially when associated with prior familiarity with the setting. They also report that what is learned is retained for as long as one month after

the experience. Falk and Balling (1980) and Falk (1983a) recommended that in order to reduce the novelty effects, students should be provided with orientation materials prior to the visit and that these activities should be structured. These organizers should then provide the students with the needed structures to be able to view exhibits collecting specific information and attending to the intended messages. Wright (1980) reported that students presented with classroom instruction had significantly higher achievement on post-testing following a structured museum visit than those who had the classroom instruction only. Gross and Pizzini (1979) and Gennaro (1981) found that advance organizers combined with field trip experiences were effective in positively influencing both cognitive as well as affective learning. Gennaro (1981), however, cautions that these results should be more carefully studied with respect to ability, age and grade levels. Stronck (1983) found that structure in the form of guided tours plays a significant role in the museum visit. For 5th, 6th, and 7th grade students there was a greater cognitive outcome from the museum experience if they participated in the structured guided tour treatment condition. Although attitudinal data was collected, the results were inconclusive as the students entered the study with already positive attitudes. Flexer and Borun (1984), in a comparison of the effects of the combination of a structured museum classroom lesson and

exhibit visit, found that the structured lesson alone was better than the exhibit experience. This study confirmed the results found by Linn (1980) that direct lecture demonstration followed by the museum experience was better than in the reverse order. Koran et al. (1983), in a study of the effects of a descriptive panel on the outcome of a visit to a walk-through cave exhibit, reported that the panel significantly enhanced visitor outcome when the panel was present. However, due to the "select" nature of the study group, the expected differential effects between forward and backward review or shaping were not verified.

Overall the museum based research supports the hypotheses stated in the previous section. This research, however is solely focused on the concept of organizers and produced little information on how one should address the various ability levels and individual characteristics of the museum visitor.

Museum Visitor Characteristics

Characterization of the museum visitor is difficult due to the nature of the institution. Museums have been characterized by most authors as places where informal learning takes place. The visitor is continuously moving between activities such as learning, entertainment, and socialization. Individual characteristics such as age, sex, educational background, cultural heritage, etc. all play a

significant albeit yet unidentified role in mediating the processes information exchange process that takes place between the visitor and the exhibit. Miles (1988) suggested that the critical characteristic of visitor activities is that they are essentially stress free thus implying that visitors themselves should be under relatively little stress. Alt (1980) in a study of the British Museum (Natural History) found that visitors were equally as likely to be male or female, to be below 11 years of age or between 25-34 (range 17-44), generally accompanied by family or friends and that over 60% were accompanied by children. This is confirmed for American institutions by DiMaggio, Useem, and Brown (1978) who summarized of a number of visitor studies across the art, science, history, natural history, anthropology, and general museums. A median of 72% of museum visitors had at least some college education, 54% of the visitors were female (48% in science museums), 42% of the visitors were professionals--includes teachers, and the median age was 31. This appears to agree with the results that Alt (1980) and Alt and Griggs (1982) reported with respect to educational level of visitors to the British Museum (Natural History). Approximately two-thirds of the visitors have completed their full-time or formal education (beyond the sixth form). Griggs (1990) also reported that between 75% and 80% of visitors have no formal educational qualification in biology. Of those that are qualified they

are only qualified up to the level of 15-16 year olds (Griggs, 1990). This concern with biology is of particular interest to museums of natural history and zoological parks. Griggs (1990, p. 80) further reported that in their studies of the museum visitor "whole areas of ignorance as well as misconceived and preconceived ideas" have been found. Bassett and Prince (1984) broadly summarized visitor characteristics by stating that visitors come from a wide age range with varying levels of literacy, visual-spatial understanding, personality, and modes of perception as well as economic, ethnic, social and educational backgrounds. In attempting to determine how visitors selected the exhibit they visited, Alt (1980) found that two factors were involved: visitor intentions or interest and the physical layout of the museum proper. Miles (1986, p. 77) found that a great majority of the visitors are "specifically" uninformed but that they can be motivated to spend time and invest energy in attending and learning from exhibits.

Variations in behavioral characteristics of the museum visitor are of interest for it is often these behaviors that are used to infer that learning or understanding are present. Koran, Longino, and Shafer (1983) in conceptualizing museum research broadly summarized a number of science/natural history museum visitor behavior patterns and characteristics in the following way:

1. Family groups, class groups, solitary individuals, minority members, bilingual visitors, and visitors of different ages and sexes manifest many patterns of behavior in common and some that are distinctly different depending on the person and the type of exhibit confronted.
2. Male and female behavior differs in the museum setting; adult males seem to peruse objects quickly and cover a lot of territory; females seem to linger longer on one object. → look up definition!!
3. For the most part, adults move rapidly while children tend to linger at exhibits.
4. "Visitors frequently appear disoriented" (p. 328) and in general "museum visitors tend to view exhibits out of planned sequence" (p. 326).
5. Adults tend to look around more than children to see what other adults (and children) are doing and to see if others are watching them in hands-on situations.
6. Older adults are more hesitant to push buttons than younger visitors (p. 328).

The authors also found that when comparing exhibit types, the dynamic or those that allow for a wide range of multisensory activities encourage a wide variety of verbal as well as social behaviors. Koran, Foster, and Koran (1989) reported that length of visitor attention to exhibits is essential for learning. In addition related to this is

visitor interest. This is supported as well by work done by Shettel et al. (1968) who observed that for visitors to an exhibit at the Museum of History and Technology, individuals with greater prior knowledge about science tend to learn more than those with less. Koran et al. (1984) reported on a study of attention and holding power as related to curiosity and found that a significant number of visitors preferred manipulatable settings. Children preferred hands-on experiences more than adults; female adults and children preferred hands on activities more than males and male children preferred hands-on activities more than adult males. This work was supportive of earlier findings that both adults and children are attracted to novel as well as complex hands on activities (Koran & Longino, 1982).

Curiosity, which is often discussed as an important variable in relation to informal settings, and museum education in particular, is another characteristic of museum visitors that has been suggested to be of importance. With respect to studies in formal educational settings, Engelhard and Monsaas (1988) investigated the effects of school (public vs. Catholic) on curiosity by looking at changes in curiosity as a function of grade level. Their results, which are limited due to research design problems, indicated that curiosity "decreases as a function of grade level," and the effects are greater in Catholic as opposed to public schools (p. 25). The study is worth mentioning because

other authors have also suggested that the effect of schools on curiosity is a negative one.

Studies in museums, however, provide some interesting results. Peterson (1979) offered contradictory or perhaps more appropriately clarifying information to the discussion of the decline of curiosity in school. Using a museum setting and objects in a longitudinal study of the same group of subjects from age 6 to 18, Peterson found:

1. The form of curiosity from childhood to adolescence changes qualitatively--younger children explore objects, whereas older children spend more time exploring books and magazines.
2. Sensorimotor curiosity does not decrease from childhood to adolescence and remains relatively high.
3. Five- to 18-year-old students explore with great interest when given the opportunity.
4. Individual styles or modes of expressing curiosity (sensorimotor versus verbal) may be relatively permanent by elementary school age (pp. 190-191).

Camp, Rodrigue, and Olson (1984) reported on adult curiosity as a function of age. In a review of the literature they concluded that the perceived value of the information may play a critical role in influencing adult curiosity:

1. Curiosity in younger adults (25-35 yrs old) is more often the result of boredom and monotony (diversive

curiosity) which the authors interpreted as a search for stimulation.

2. For young (25-35 yrs old) and middle (45-55 yrs old) aged adults there is a positive relationship between perceived value and desire for additional knowledge. The strength of the relationship decreases with older (65-75 yrs old) age.
3. No age effects are found on measures of specific curiosity. Age is not related to search of information.
4. Age differences can be found in willingness to expend energy and perceived meaningfulness of tasks (Camp et al., 1984, pp. 397-398).

They concluded that "learning is meaningful to the degree that the new learning task can be related to the existing cognitive structure" of the individual (Camp et al., 1984, p. 398). This research lends support to the cognitive process connections made previously by other authors and discussed in previous sections. Setting also appears to have a particularly strong enhancing as well as deleterious effect on visitor behaviors and their development. Formal or traditional settings appear to have a negative impact; whereas the scant information on informal or museum settings indicates a more positive effect. Miles' (1986) three conditions for motivating visitor interest appear to be supported by the above-mentioned results: the free choice

setting, learners need to perceive the problem as an enjoyable challenge, and there is a facilitating effect in being able to provide a range of methods or ways in which to learn. It also becomes apparent that often visitor characteristics are also interwoven with the outcome characteristics of the museum experience.

Outcomes

Earlier in this review one of the primary outcomes of the museum visit was stated to be learning and cognitive change. Aronson and Briggs (1983) and Gagne and Driscoll (1988) suggested that there are five major learning categories--intellectual skill, motor skill, verbal information, cognitive strategy, and attitude. These categories would appear to reasonably cover a majority of expected outcomes from a museum visit with the possible exception of those considered to be social in nature (Table 2-1). Within the intellectual skill category, structure and sequencing are of implied importance in that subcategories begin with basic forms of associative learning and proceed through discriminations, concepts (concrete and defined), rules, and higher order rules, each requiring the previous category as a prerequisite for attaining the next level. This framework (see Figure 2-5) would appear to be of value in guiding museum outcome studies as many exhibits as well as numerous studies and evaluations of exhibits have as

Table 2-1

Learning Categories

Learning Category	Type of Performance	Museum Performance
Intellectual	abstracting, inferring, problem solving, etc	reading, and relating information from various exhibits or exhibit components
Motor Skill	using coordinated body movements	activating interactive exhibits: pushing appropriate buttons, working computers, etc.
Verbal Information	recalling facts, etc.	answering questions about exhibit facts, recalling scientific and common names, etc.
Cognitive Strategy	metacognitive activities, novel problem solving, etc.	working through interactive exhibit and arriving at solutions based on exhibit information
Attitude	behaving in situation appropriate ways	enjoying museum visit, attending to exhibit content and details, etc.

based on Aronson and Briggs (1983)

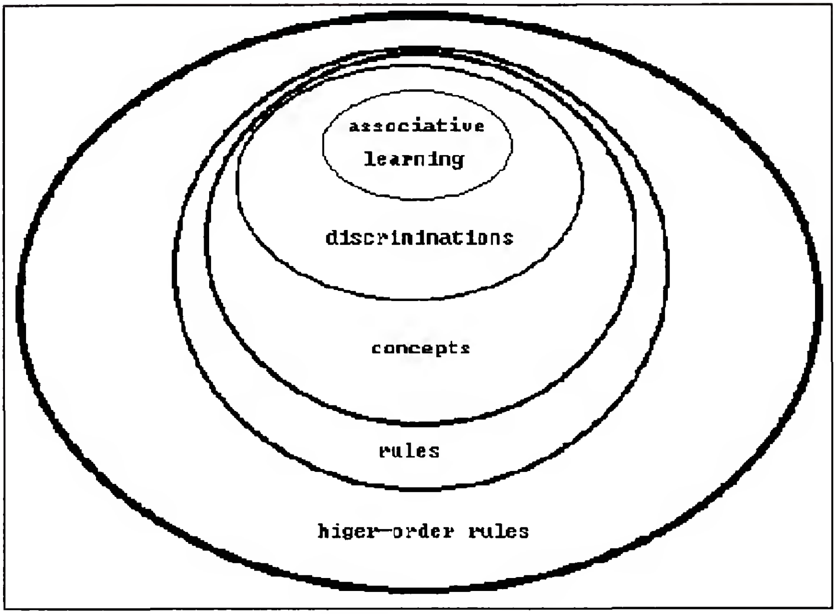

Figure 2-5. Intellectual Skill Subcategories. Adapted from Gagne and Driscoll (1988).

their focus the conceptual framework and associated learning related to the particular theme of the exhibit. Belland (1986) in fact suggested that "concept learning" is an outcome of the museum experience that is "well suited to the normal functioning of most museums" (p. 86). Belland further suggested that concepts are formed via experience in a variety of contexts. Discrimination between features of objects, identifying objects, classifying verbal information, demonstrating/applying/representing learned information, and using that information in other activities all are features that can be seen to be possible outcomes of viewing museum exhibits. Belland, however, cautioned that in the museum setting, concept learning is limited to that of the designer and that under some circumstances the museum learner is "only allowed to experience" the results of the curator's choices as well as learning thus participating in a rote learning activity. Belland further suggested that since the exhibits are already formulated on the basis of some preplanned concept, visitors are not encouraged to develop their own concept or at least provided with the necessary direction by which they can modify their existing concept framework and thus learn. In fact, as discussed in the exhibit design section, visitors who are not being provided with the required directions may be "discovering" on their own the base concepts for a particular exhibit (at the very best), forming completely unexpected concepts

(correct as well as well as erroneous ones), using improper concepts, or at the very least nothing at all happens. Lakota (1976) can be quoted to have concluded that by relying on the "romantic notion" of "discovery," museums are assuring that fewer visitors benefit from their visit and avoiding the need to be specific about the objectives/goals of exhibits (C.D.T., 1976, p. 19). This raises the question as to how concepts are defined and what are the requirements for concept learning.

In the broadest sense the cognitive structure of an individual contains at any point in time all that an individual has learned with the products or outcomes being classified as information (perceptual, visual, verbal, etc.), concepts, structures (taxonomies, hierarchies, schema, etc.) and as strategies or skills (cognitive, problem solving, etc.) (Klausmeier & Sipple, 1980). Concepts are often commonly thought of as mental or internal representations that are stored as meanings, relationships, symbols, etc. Concept definitions also appear to fall into three "views". The "classical", which according to Balzano and McCabe (1986) has been largely discredited, holds that concepts are defined by their necessary and sufficient features. The "probabilistic" is similar to the classical in that internal representations contain abstract summarizing information but differs in that in this case, this information need not be true for all instances of the

concept. The "exemplar" view holds that what is stored is a literal copy of the objects or instances encountered. In any case they report that empirical support for these views is weak at best and they continue to support the more general view of concepts as "conjunctions of properties selected by the mind" (p. 100). This view suggests a form of hypothesis-testing and -confirmation approach to concept formation. They pointed out that this leaves the question unanswered as to why certain concepts arise instead of others and that there is no guarantee that "useful" concepts will be constructed. They recommended that an ecological approach be used whereby research focuses on the way individuals interact with objects in their environment which should then reveal information on their concepts. Psychologically, concepts have also been defined as the ability to "generalize within classes and discriminate between classes" (Mechner, 1965, p. 461). Bourne, Dominowski, and Loftus (1979) in a historical as well as summative perspective provided several definitions for a concept which can be seen as

a. those elements or stimulus features which members of the class held in common;

b. "a multiplicity of clues, some of which are common to a given category and therefore relevant to that category and others of which are not common or are irrelevant" (p. 167);

c. "an abstraction in the sense that it refers to no particular object, process, state of affairs, or event but rather to a collection of such concrete entities" that have two fundamental components: a set of defining features and a relationship among them (p. 194).

Klausmeier and Sipple (1980), as well as Gagne (1974) and Markel (1977), differentiated among a number of forms of concepts. "Concrete" concepts are those that have perceptible attributes (color, animal, etc.) whereas "defined" or "abstract" concepts are those with attributes that cannot be readily pointed to (diagonal, pivot, etc.). Other distinctions include "generic" versus "specific" whereby a generic concept is all inclusive (animal includes dog). Important structural and sequencing aspects of concepts and their formation have also been reported. Gagne (1970) clearly suggested that concept or skill acquisition is a hierarchical process with the lower level concepts being acquired and gradually integrated to form higher level concepts. Bourne, Dominowski, and Loftus (1979) reported that research supports the idea that natural concepts are hierarchical in nature with a basic level containing information (reduced to as few classifications as possible) about the object and the higher levels containing condensed or more abstract information. Balzano and McCabe (1986) reported that concepts are related to one another in a hierarchical manner with the larger inclusive concept at the

top and defined by features common to the lower level concepts, thus implying a structural component. At the basic level there is the object description in which objects share many features or properties and "share ways in which persons interact with them" (Balzano & McCabe, 1986, p. 97). Mechner (1965) suggested that for broader concepts, sequential discriminations and generalizations about a variety of concepts may be needed. Mechner, in what may be an oversimplification of the instructional aspects of teaching generalization and discrimination, stated that the process is rather "straightforward" being technically problematic only insofar as the identifications of the properties to be generalized and discriminated. This is highlighted by Case (1975) who also found that the Gagne hierarchical approach is helpful in that it allows a learner to be led through a series of intermediate activities that will lead to the terminal concept. Klausemeier and Sipple (1980) suggested a structurally similar successive four step model for concept attainment involving an initial concrete level whereby attending, discriminating, internally representing an object and remembering the representation. This they suggested was followed by an identity level whereby objects are recognized independent of their contexts and where generalization occurs to make this identity possible. The classificatory level implies a higher level of discrimination between a variety of examples and non-

examples of concepts. At the formal level concepts can be defined and examples can be reliably compared against non-examples. Attainment of these various levels is suggested to be related to the content domain and the abstractness of the examples. Concept learning is suggested to be formed through active strategic hypothesis testing whereby the individual learns both the defining features and the relationships among them (Bourne, Dominowski, & Loftus, 1979).

Conditions that would affect the process of concept learning can be summarized to include the (a) definition of the task (Does the visitor know that there is a concept to be learned? Is the learner seeking to attain a concept?); (b) the nature of the "validation" (Are there sufficient instances--positive and negative-? Can the learner readily check on hypotheses formed?); (c) the consequences of particular categorizations (Is there a price associated with right and wrong?) and (d) the types of restrictions placed on the process (Are there sufficient external aids? Is there a sufficient mix of verbal, visual, and other supportive sensory information?) (Bruner, Goodnow, & Austin, 1973). These four conditions have been broadly summarized by Gagne (1985) into the conditions within the learner and the conditions within the situation.

Exposure to three-dimensional examples in a particular context and experienced early in life are reported to be

learned earlier than those concepts that can only be represented symbolically (Gagne, 1985; Gagne & Driscoll, 1988; Klausemeier & Sipple, 1980). Individual differences also appear in concept learning with intrapersonal (students in particular) variations occurring across subject areas (Klausmeier & Sipple, 1980). Mastery of concepts between individuals is also reported to be variable and dependent on the subject matter as well as the information coordinating capacity of the individual, thus leading to suggestions that instruction be adapted to the learning characteristics of the individual (Case, 1975; Klausmeier & Sipple, 1980). Case (1975) criticized the Gagne model as not accounting for these individual differences, more specifically for cognitive capacity especially of young children. Information-processing capacity as reported by Case (1975) is reported to level off at 15-16 years of age. Field independence which relates to the degree to which the "organization of the prevailing field" determines what is perceived is also reported to change until age 16 (Case, 1975; Witkin et al., 1962, 1977). Case further speculated that for young children the absence of the ability to avoid making what early on is a natural or spontaneous set of choices should be the educational focus. Information-processing capacity and an inability to overcome one's field "dependence", however, must be dealt at all ages by adapting instructional systems or exhibits (in the case of museums)

to the learner. Case (1975) suggested this can be done through practice, chunking, narrower "hierarchy spans", etc. which should allow for the strengthening and integration of responses to form the desired concept. Concept learning, therefore, is an outcome that can be expected from the museum experience. As noted in Figure 2-1 and in the discussion above, outcomes such as concept learning are expected to be affected by the nature of the stimulus (exhibit in this case), the characteristics of the learner and the processing activities required.

Other outcomes that have been reported by a number of authors include changes in attitudes towards museums, science and related subjects; curiosity; increased stimulation; shared experiences; and social learning (Borun, 1977; Falk, nd, 1982, 1983b; Graburn, 1977; Loomis, 1987; McManus, 1987, 1988; Miles et al., 1988). In general the majority of studies in museums study a variety of outcomes based on the orientation of the researcher. These outcomes also vary on the basis of the nature of the exhibit (static to dynamic) and its physical makeup as well as layout.

Outcome measures used in museum research have been based in general on measures used both in educational research and psychology studies. No measures have been reported that can be considered typically associated with or unique to museums. Typically studies in museums have measured verbal ability (verbal content) and/or spatial

abilities (pictorial content); however the use of these measures independently from consideration of processes involved in the exhibit, or instructional programs is no longer advisable (Koran & Koran, 1984). Other measurable outcome variables that have been identified from the literature by Koran and Koran (1984) as giving consistent aptitude treatment interaction results include measures of general ability, anxiety, prior achievement and achievement orientation.

With respect to general ability, Koran and Koran (1984) reported that in general, research results indicate that high ability individuals do better in settings that require them to solve, organize and build their own meanings. On the other hand the more the instructional program or exhibit does by way of information processing for the learner, the better for low ability students. Inductive methods therefore appear to be better for high ability individuals whereas deductive methods, which are used traditionally as the museum exhibit design method, are better for low ability students. Koran and Koran take this further in reporting that literature suggested that verbal abstract concept treatments are generally better for high ability learners and that simple diagrammatic symbolic representations which supplement verbal abstract content are better for low ability students. Alternative treatments based on general ability should then be feasible in a museum setting.

Anxiety as a measure is more and more an appropriate consideration when dealing with formal structured classroom type settings. The average museum visitor is under no constraints beyond those which the visitor personally sets. Exceptions may exist in that guided activities, programs and fairly complex concepts may be presented for viewing and upon which visitors must make a decision to either view or not view especially in a family or group situation. Although these findings have not been assessed in museums, Tobias (1979) and Koran and Koran (1984) reported that the greater the difficulty of the problem the more disadvantageous the experience is for the highly anxious. In addition highly anxious individuals require memory supports as well as greater organizational support externally so that they can better attend to the activity at hand and recall as well as incorporate the given information. Finally achievement motivation appears to also significantly mediate learning. Cronbach and Snow (1977) as well as Koran and Koran (1984) reported that students who are encouraged to work on the basis of their preferred achievement style (via independence or via conformity) generally do best.

It is apparent from the literature that outcomes from the museum experience can be varied as well as dependent on a number of individually different variables. A review of research into the interaction between the visitor and museum

exhibits reveals considerable study of the effect of exhibit characteristics such as letter size, exhibit type (static vs dynamic), visitor behavior, etc. (Bitgood et al., 1986a; Bitgood et al., 1986b; Borun & Miller, 1980; DeMouthe, 1989; Falk et al., 1985; Peart, 1984; Serrell, 1981). Optimal letter size, text length, mix of graphics and text, height and composition of the exhibit, and physical layout as well as numerous other variables have an impact on the outcome of the museum experience. It appears, however, that there is strong support for the conclusion that informing the visitor of the organization, structure and sequencing of the exhibit and/or how to view the exhibit may be the critical variable that to this date has neither been used effectively nor investigated to any significant extent.

Perspectives Research--A Unifying Theme for Museum Studies

Research into providing visitors with some form of schema or framework with which they can organize and elaborate exhibit information is clearly indicated by the above-mentioned studies. Furthermore, based on the work of Anderson (1970), Screven (1975), Lakota (1976), Wittrock (1978), Brown, Campione, and Day (1981), Anderson, Pichert, and Shirey (1983), Miles (1988), and Koran, Koran, and Foster (1989) it would appear that providing an orienting perspective or schema to the museum visitor would encompass many if not most of the recommendations with regards to

structure and sequence previously discussed. Anderson, Pichert, and Shirey (1983) suggested that individuals attempting to read and understand text have a similar need and in fact find that readers consistently make inferences and recall information based on their perspectives and/or schemata. This area of study would, therefore, appear to unify many of the museum based findings and recommendations as well as provide a theoretical basis for further studies. A brief review of perspectives related literature would therefore appear to be appropriate.

Museum based "visitor perspectives" studies have not been done to this date. A 1975 study by Winkel et al. is perhaps one of the earliest studies that touches on this area, although in an oblique way, in suggesting that the entire area of exhibit relationships from the "visitor's perspectives is a very rich source for further exploration" (p.xi). Most recently Volkert (1991, p. 48) suggested that museums are entering a phase whereby exhibits "present multiple perspectives and encourage visitors to shape their own experience." As previously stated the basis for this approach is what Volkert called core statements for exhibitions that include the message as well as the relationships that the museum wants the visitor to receive. The validity of this approach is questionable as no museum based evidence is provided that the visitor actually understands and utilizes the designer's core statements.

Theoretical support for this concept, however, can be found in the title biasing studies of reading comprehension by Bransford and Johnson (1973), Schallert (1976), Schwarz and Flammer (1981), and Brooks, Spurlin, Dansereau, and Holley (1983). They found that presenting subjects with headings, text titles or thematic titles before reading a passage facilitated recall from both comprehensible as well as ambiguous text. These studies also formed the basis for much of the perspectives research in cognitive psychology.

Anderson (1970) implied the role that perspective-taking might play when he suggested that for learning from verbal materials, three mediating processes are required--attention to the stimulus, encoding, and the conceiving of relationships or linkages between the aspects of the stimulus or more critically the aspects that would later serve as cues and the response. Furthermore, it is suggested that learning is facilitated when the learning task requires some form of deep processing thus becoming meaningful (Anderson, 1970). On the other hand, a key assumption of the perspectives approaches to knowledge acquisition is the view that the knowledge that individuals already have forms the basis for what a person can learn (Anderson, 1977, 1984). Bransford, Barclay, and Franks (1972, p. 195), in a study of the contrast between a constructive/interpretive approach to sentence memory, found evidence that subjects construct "wholistic semantic

descriptions of situations." Accordingly new information is taken into preexisting knowledge structures or schema and depending on the context into which the information is incorporated, its implications for further learning may be affected. This is supported by Bransford and McCarrell (1974, p. 220) who suggested that the ability of an individual to understand perceptual events is based upon the ability to use ones "general knowledge to create situations" that allow presented relationships to be envisioned or imagined. Anderson (1977a, p. 419) suggested that comprehension relies on the ability of the learner to "discover a formulation which coherently explains" what is being perceived by the sensory inputs. Bransford, Nitsch, and Franks (1977, p. 48) further clarified the relationship by stating that "past experience provides an increasingly precise and differentiated framework that sets the stage for perceiving, understanding, and acting" and that "effective learning therefore seems closely akin to perceptual learning where the latter involves a process of differentiation rather than enrichment by storage of subsequent facts." This they suggest leads the learner from the perspective of *"thinking about"* to "*thinking in terms*" of information, thus avoiding context bound calculations, etc. in order to understand or comprehend the particular activity or exhibit in the case of museums. The former implies fact acquisition and the latter ways of "seeing" and suggests what Bransford,

Nitsch, and Franks (1977, p. 51) called a "remodelling of one's perspective." They support this hypothesis by referring to work done by Hannigan (1976) who they reported as finding information recall of both new and old information for individuals who were provided with a "thinking in terms of" perspective over those who were presented with a facts only perspective prior to hearing information. High-level schema or knowledge structure may provide individuals with the "ideational scaffolding" as well as "interpretive framework" needed for comprehending text, discourse, etc. (Anderson, Reynolds, Schallert, & Goetz, 1977b; Pichert & Anderson, 1977). The strength of this dominant schema can result in individuals being completely unaware of alternative explanations for information being presented to them (Anderson et al., 1977b). Of particular interest to museums is the hypothesis that, based on studies of high-level schemata that individuals bring with them, that "the schemata by which people attempt to assimilate texts will surely vary according to age, subculture, experience, education, interests, and belief systems" (Anderson et al., 1977b, p. 378). However, evidence supporting this contention is not presented.

Pichert and Anderson (1977) in a study of reading comprehension and memory found that individuals learn more of the important information than unimportant ideas in

passages and that the importance of any particular idea is dependent on the perspective an individual takes. "It was an idea's significance in term of a given perspective that influenced whether it was learned and whether it was recalled" (Pichert & Anderson, 1977, p. 114). This is in part supported by d'Ydewalle, Degryse, and Swerts (1982) who reported that details or important "idea units" are better recalled if they are present in the initial sections of text or if they are important for comprehension of the storyline. In an attempt to more clearly discern the underlying processes that take place when perspectives are used, Anderson and Pichert (1978) introduced a perspective shift following the reading and initial recall of a given passage. Their results supported the overall conclusion that some irrelevant information is encoded during information processing and that given a new and connected perspective or schema this information may be retrieved. This study, however, was unable to detect whether the underlying processes were primarily ones of a retrieval plan (search from generic knowledge to specific information stored at time of encoding), output editing (information indexing for searching within schema), or inferential reconstruction (missing information is filled in based on other existing information). Mayer and Bromage (1980) in a related study using advance organizers defined as "a system for logically organizing the incoming information into a unified

structure" reported results supporting both encoding and assimilation processes of knowledge acquisition. Their results confirmed that individuals provided with organizers prior to text reading "performed better on test questions involving transfer to conceptually more distant tasks . . . whereas subjects given the model after reading the text tended to excel on near transfer tasks that were similar to the information presented in the text" (Mayer & Bromage, 1980, p. 223). Therefore, it is possible to infer that those receiving the organizer prior to the task acquired more connections to concept or knowledge already in memory. Spiro and Bromage (1980) further speculated that the organizer can only provide meaningful learning if it is available during learning and that the use of models that encourage narrow learning outcomes (after) with few linkages can actually retard meaningful learning. Anderson, Pichert, and Shirey (1983) concluded that perspectives presented before, shortly after, and long after (2 weeks) reading have a pronounced effect on recall from reading text information. The schema activated by these perspectives serve to selectively enhance if not focus encoding and retrieval of information in memory.

As mentioned early on, inherent in the perspective taking approach is the underlying assumption of pre-existing knowledge structures. Although strong evidence supporting perspective approaches exists, a caveat can be found in the

work of Grabe (1979) who found no significant difference in responses between subjects provided with a used car buyer or homebuyer perspective and those only reading given passages that could be read from two viewpoints. Based on interviews with the college students in the study, Grabe hypothesized that the students were unable to use the perspective because they did not have the necessary knowledge to be able to support or organize the schema underlying the perspectives. These results provide incidental support for the above-mentioned hypothesis (Anderson et al., 1977) that the effects of perspectives may vary with age, culture, etc. Goetz, Reynolds, Schallert, and Radin (1983), in attempting to determine the role of reader's background and interests, reported that reader's background affected reading times. Experienced subjects, actual policemen, who were given the burglar perspective spent more time on the information of interest to burglars; however the comparison group, community college real estate students, did not. These findings would appear to be in keeping with the findings of Grabe (1979) that pre-requisite knowledge plays a role in the ability to use a perspective. Further evidence for individual differences is reported by Spiro and Tirre (1980) who hypothesized that individuals differing on Embedded Figures tests should differ in their use of perspectives. They theorize that Embedded Figures tests (EFT) should be able to provide evidence on a subject's ability to

superimpose structure from memory onto a stimulus and thus use preexisting knowledge schema in a given processing task. Mixed results were reported. Spiro and Tirre found that given the same text structure in the passages, low and high EFT scorers did equally well on a less constrained supermarket perspective; however they differed strongly on the more particular restaurant perspective. d'Ydewalle, Degryse, and Swerts (1982) found similar results with those scoring high on the Group Embedded Figures Test "distinguishing more efficiently the high important idea units from less important ones" in texts used in their study.

Perspectives research therefore appears to offer a unifying concept which can both provide museum visitors a knowledge based orienting framework or schema linking their knowledge to that contained in an exhibit and also provide museum professionals with the appropriate tools to reach different types of visitors and offer them the opportunity to enhance their visit by improving their understanding of the museum message.

Summary

It is evident from the literature that the interaction of exhibit design characteristics, visitor processing activities, visitor or individual characteristics and outcomes can significantly influence the intended message(s)

of an exhibit. Additionally it is evident that little research has been done to explore these aspects either individually or as they interact. Consequently this review has drawn heavily on research in formal settings.

As will be recalled, museum exhibits are generally thought to be structured and most often sequenced with respect to their content. Exhibit content is often based on some concept or related framework that originates as the result of curatorial efforts (Miles et al., 1988; Neal, 1976). Melton (1935), Melton, Feldman, and Mason (1936), Abler (1968), Lakota (1975), Winkel et al. (1975), Lakota and Kantner (1976), and Alt and Shaw (1984) have all reported that visitors are most likely to approach and attend to an exhibit out of sequence unless otherwise informed. Gibson (1925), Bloomberg (1929), Melton, Feldman, and Mason (1936), Ramsey (1938), Shettel et al. (1968), Anderson, et al. (1977b), Falk, Martin, and Balling (1978), Grabe (1979), Gross and Pizzini (1979), Falk (1979), Linn (1980), Falk and Balling (1980), Gennaro (1981), Falk (1983a), Koran et al. (1983), Stronck (1983), and Flexer and Borun (1984) provided evidence based on studies of students and visitors suggesting an hypothesis that visitors in organizing information may act differentially based on ability, prior knowledge and educational level. Screven (1969) and DeWaard et al. (1974) in a study of visitors using exhibit adjunct materials (audio and programmed cards)

reported that learning was significantly better for those using the aids. These results would further lend support to an hypothesis that if visitors can find some means of organizing information presented in an exhibit they will find it easier to attend to more information (Alt & Griggs, 1984; Anderson, 1970, 1977, 1984; Ausubel & Fitzgerald, 1962; Miles, 1988; Screven, 1975). Similarly an orienting perspective can also be surmised to be facilitative based on the work of Bransford and Johnson (1973), Schallert (1976), Pichert and Anderson (1977), Schwarz and Flammer (1981), Anderson (1970, 1977, 1984), and Anderson, Pichert and Shirey, (1983). As will be recalled this line of inquiry is also supported by the work of Atkison and Shiffrin (1968), Gagne (1970, 1985), Wittrock (1978), Mayer (1979), Sternberg (1979), Klausmeier and Sipple (1980), Koran, Longino and Shafer (1983), and Gagne and Driscoll (1988) which provides an information processing framework within which concepts are formed and information is inferred to flow in a systematic and structured way allowing for learning, assimilation, elaboration and transfer.

It should also be recalled that a key assumption underlying the design process is that visitors have the essential or previously learned prerequisite knowledge or skills as well as those supportive prerequisites that facilitate the learning process (Lakota & Kantner, 1976). Cognitive psychology studies by Rothkopf (1970), Anderson,

1970, 1977, 1984), Wilson and Koran (1976), Mayer (1979), Brown, Campione, and Day (1981), Salomon (1983), and Anderson, Pichert, and Shirey (1983) provide evidence supporting the hypothesis that visitors who are provided with ways of how to consciously monitor their knowledge, learning strategies, and information on exhibit complexity in conjunction with cues and structures within the exhibit proper will gain significantly from their museum experience.

Case, (1975), Koran, Koran, and Freeman (1976), Wilson and Koran (1976), Cronbach and Snow (1977), Grabe (1979), Spiro and Tirre (1980), Goetz et al. (1983), and Koran and Koran (1984) further expand the above-stated hypothesis by reporting on results that suggest that variations in outcome can be found to be dependent on individual differences in cognitive capacity, prior knowledge, field dependence, general ability and mode of instruction--in general, single hypothesis, organizers, questions, and structured/deductive instruction are best for low ability individuals. Lakota and Kantner (1976) and Koran et al. (1983) provide supporting evidence that the provision of learning support materials would not be detrimental to high ability individuals. In fact based on the results reported by Koran, Koran, and Freeman (1976) and Lakota and Kantner (1976), it could be hypothesized that two forms of support could be provided based on the exhibit framework with wider range exhibit knowledge being supported inductively and

lower level objectives being supported deductively. This might be in the direction that Taborsky (1990) and Volkert (1991) call a discursive interaction (deductive x inductive) vs the traditional observational interaction (inductive) between the visitor and the object. Peterson (1979), Koran, Longino, and Shafer (1983), Camp, Rodrigue, and Olson (1984), and Miles (1988) provide additional evidence for the hypothesis that museums must provide a range of methods that facilitate learning not only based on cognitive characteristics but on sex as well as age.

Providing visitors with learning support should take advantage of learning skills/abilities already present in the individual visitors, enhancing their means for directing observations, for understanding and for perceiving (C.D.T., 1976; Lakota & Kantner, 1976). Given the findings and general conditions suggested by the research discussed above the following conclusions appear to be a natural progression for inquiry into "what the visitor needs to know and do in order to learn" from a museum exhibit (Miles, 1986, p. 228).

Subjects receiving a treatment consisting of an exhibit whose content is organized in a sequential manner should perform significantly better on a written criterion measure based on exhibit content than those experiencing the exhibit in a non-sequential manner. Furthermore, subjects receiving a treatment consisting of an exhibit whose content is organized in a sequential manner will perform significantly

better on written criterion measure based on exhibit content if they are presented with a perspective on how the exhibit should be perceived versus those receiving no perspective. Finally, there will be a significant difference, following interaction with the treatment exhibit, between subject performance on written criterion measures, based on exhibit content, and subject aptitudes (sex, science skills, verbal ability, and field dependence/independence).

CHAPTER 3
METHODOLOGY

Research Hypotheses

Based on the findings presented in the literature and conclusions stated at the end of Chapter 2 the following research hypotheses were indicated:

Main Effects

H_1. No relationship exists between the aptitudes (verbal comprehension, embedded figures, and science reasoning skill) and the post-test scores.

H_2. No relationship exists between gender and the post-test score.

H_3. No relationship exists between perspective and post-test score.

H_4. No relationship exists between sequence and post-test score.

Two-way Interactions

H_5. The relationship of perspective with the post-test score does not differ by the effects of sequence.

H_6. The relationship of aptitude (verbal comprehension, embedded figures, and science reasoning skill) with the post-test score does not differ by perspective.

H_7. The relationship of aptitude (verbal comprehension, embedded figures, and science reasoning skill) with the post-test score does not differ by sequence.

Three-way Interaction

H_8. The relationship of aptitude (verbal comprehension, embedded figures, and science reasoning skill) with the posttest does not differ by the combined effects of sequence and perspective.

Experimental Design

This study's experimental design consisted of a post-test only control group design with random assignment of subjects to treatment groups defined by perspective and sequence (Table 3-1) (Campbell & Stanley, 1973). Randomization was expected to assure the researcher that the groups are randomly equivalent thus eliminating the need for a pretest. The use of a pretest is not desirable for a number of reasons. Of primary concern in this study is the threat to internal validity resulting from the pretest cuing the subjects or acting as an advanced organizer thus becoming another treatment. Additionally, Campbell and Stanley (1973) suggest that if the desire is to be able to

Table 3-1

Design of Study

Aptitude tests	Assignment	Orienting instructions	Exhibit order	Exhibit order	Posttest
		Perspectives	Sequenced	Nonsequenced	
X	R	zoology	n= 29	n= 28	X
X	R	geology	n= 28	n= 28	X
X	R	no perspective	n= 28	n= 28	X

Total subjects -- n= 169

generalize to larger unpretested populations the pre-test only control group design is most appropriate with large samples. Finally, as the perspective giving instruction prior to exposure to the treatment exhibit is the independent variable it was necessary to remove any potential for confounding with the pretest. However, since this study was based on a science concept in a natural history museum a general science knowledge test was used in place of a pretest. The purpose is to collect information on the science knowledge level of the subjects prior to exposure to the treatment. Its items avoided any cuing or otherwise confounding effects an exhibit specific pretest might have had.

Since randomization is used in this discussion and in the following sections, it is appropriate to describe the method used. Appendices A, B, and C are a listing of the SAS computer programs and printouts utilized to get a series of random numbers for the various uses both previously discussed and to be discussed below. It can be noted that the program randomly assigns a number between zero and one for the listed **Y** variable, i.e. the subject number, test item number, or exhibit case. The random **X** number is then utilized to either assign to the treatment conditions, to reorder the posttest questions or exhibit case.

Exhibit Conditions

The exhibit used in this study was the newly constructed Fossil Study Center at the Florida Museum of Natural History (Appendix D). Paleontology, or more specifically Florida fossils, is the exhibit's unifying concept. The sequenced condition of this study involved viewing the exhibit in the order in which the exhibit was designed and constructed (Appendix D and E). The non-sequenced condition involved the exposure of subjects to the exhibits in a random order (Appendix F). Under the latter condition each combination of exhibit wall panel and display case was randomly assigned a number and the subjects were instructed to follow the designated order (Appendix C and F). Each exhibit/case was labeled with single, black ink on white, 8.5" x 11" page identifer that included a letter, for the sequence condition, and a number, for the non-sequenced condition (Appendix G). Each subject was carefully monitored to ensure that they followed the assigned order. As in most museums, visitors are simultaneously exposed to many, if not all, aspects of the exhibit upon entry; therefore this study does not presume to "blind" the subjects to particular aspects of the exhibit. There was, however, no reference to the exhibit as the Fossil Study Center either in the instruction nor in the exhibit area itself. To maintain a similarity between conditions all numbering and added guiding devices were included under both

sequenced as well as non-sequenced conditions. No physical or other changes were made in the exhibit once the study began.

Treatment Conditions

Treatment one consisted of the subjects viewing the exhibit in a sequential manner using the "Zoologist" perspective. Subjects were handed the prepared instruction sheet and directed to begin by reading and following the instructions (Appendix E). The instruction sheet contained the "Zoologist" perspective-taking instructions, and instructions to follow the order of the exhibit from beginning to end.

Treatment two consisted of the subjects viewing the exhibit in a sequential manner using the "Geologist" perspective. As in treatment one, the subjects were instructed to follow the particular instructions which they were given (Appendix E).

Treatment three consisted of the subjects viewing the exhibit in a non-sequential manner using the "Zoologist" perspective. Treatment four consisted of the subjects viewing the exhibit in a non-sequential manner using the "Geologist" perspective. For treatment conditions three and four subjects were also instructed to follow the instructions given them as in treatment conditions one and two (Appendix F).

Treatment five consisted of the subjects viewing the exhibit in a sequential manner without a given perspective (Appendix E). Treatment six consisted of the subjects viewing the exhibit in a non-sequential manner without a given perspective (Appendix F). Subjects were given the same instructions as in the above mentioned treatments; however, their instructions contained no perspective.

These above-mentioned treatment conditions are depicted in Table 3-2.

Instructional Materials

Each subject received one of three typed instructional 8.5" x 11" "brochures" (Appendix E & F) that was returned following the treatment and prior to taking the outcome measure. Each "brochure" included the perspective-taking instructions and identified which sequence to follow, a map on the reverse side showing the stations, and instructions on time allotted. In all, six "brochures" were developed and used differing by perspective and sequence conditions.

The perspectives instructions are based on the works of Pichert and Anderson (1977), Anderson and Pichert (1978), Grabe (1979), Anderson, Pichert, and Shirey (1983), Goetz et al. (1983), Brown, Day, and Jones (1983), and Anderson and Pearson (1984). Since no clear information was provided by these authors on the directions and on how they were given

Table 3-2

Treatment Conditions

Treatment number	Orienting instructions	Exhibit order	Exhibit order	Post-test
	Perspectives	Sequenced	Nonsequential	
1	zoologist	X		yes
2	geologist	X		yes
3	zoologist		X	yes
4	geologist		X	yes
5 (control)	no persp.	X		yes
6 (control)	no persp.		X	yes

X = group participates in the particular treatment conditions indicated.

to the subjects this researcher and a research team inferred the directions from the aforementioned studies.

In all cases the subjects were instructed to follow the sequence of exhibits as indicated by the letters or numbers placed next to each panel. Subjects were not allowed to go back to previously viewed panels or cases in the exhibit. In addition subjects were informed that they may take as much time as they need.

The instructional materials were designed and reviewed by both the researcher and museum staff. Additionally the instructional materials were read by both professors and graduate students who had no science background as well as by several graduate students literate in science. All materials were pilot tested for readability and content prior to initiating the study.

Subjects

One hundred sixty nine undergraduate students from the University of Florida College of Education were recruited as subjects for this study (Table 3-1). Subjects were requested to volunteer through faculty teaching their classes (Appendix H). Faculty offered students a variety of incentives ranging from five extra points on their final course grade to extra unexcused absences during the semester. The bias stemming from the differing incentive conditions was minimized through random assignment to the

treatment conditions. All subjects were provided with an information sheet on the project and were asked to sign an informed consent release form at which time they were randomly assigned an identification number for use throughout the study (Appendix I). Data from these subjects were used in all subsequent analyses.

Measures

Subject background

Data on subject age, educational level, subject area of specialization, and prior museum experience were collected using a survey questionnaire administered after participation in the particular treatment to which the subject was assigned.

Aptitudes

Data on gender, verbal comprehension, embedded figures, and science reasoning ability were collected on each subject prior to participation in the treatment component of the study. Time spent by each subject in the exhibit was noted during the treatment portion of the study.

Verbal comprehension was determined using the 48 item Extended Range Vocabulary Test (ERVT) (Ekstrom, French, Harman, & Dermen, 1990) and field dependence/independence was determined utilizing the 18 item Group Embedded Figures Test (GEFT) (Witkin, Oltman, Raskin, & Karp, 1971). Both tests are timed tests requiring the reading of instructions

and examples and 12 minutes of actual response to the items. Due to the design of the Extended Range Vocabulary Test it was possible to provide the subjects with machine scorable answer forms, whereas the GEFT instrument was visually scored against a key provided by the instrument developer.

Verbal comprehension is defined as the ability to understand the English language and is reported to be dependent on the "contents of the lexicosemantic long-term memory store" by Ekstrom et al. (1990, p. 163). Reliabilities for the Extended Range Vocabulary Test have been reported in studies to range between 0.80 and 0.83 (Ekstrom et al., 1990). Field dependence is reported by Macleod, Jackson, and Palmer (1986, p. 142) to have been defined by Witkin et al. (1954) as the "degree to which a person can overcome embedding context in perception" and by Witkin, Goodenough, and Karp (1967) as the "extent to which a person tends to use social context for self-definition". Furthermore, Witkin et al. (1971, p. 6) reported that on the basis of previous factor analytic studies that EFT scores significantly correlate at high levels with "analytic factor IQ's" and at nonsignificant low levels with "verbal comprehension and attention-concentration factor IQ's." The value of this measure as a potential predictor is indicated as well by Spiro and Tirre (1980, p.207) who in a study of perspective taking confirmed that subjects who were "stimulus-bound on EFT would also be overly text-bound on a

discourse processing task." Reliabilities for the Embedded Figures Test include those for internal-consistency of 0.61 to 0.93 and test-retest of 0.89 to 0.92 (La Voie, 1987). The GEFT is an adaptation of the EFT with a split half reliabilty estimate of 0.82 and an GEFT to EFT correlation of between 0.63 and 0.82 (Witkin et al., 1971).

General science reasoning ability was determined by using the 40 item 30 minute long American College Testing (ACT) Program Science Reasoning Test. This test has been reported to have an internal consistency reliability (KR20) of 0.81-0.82 (ACT, 1989). Content of the test is described as being "drawn from Biology, Chemistry, Physics, and the Physical Sciences" and requiring a "background knowledge at the level of a high school General Science course" with minimal mathematical skills (American College Testing Program, 1989, p. 6).

Verbal comprehension, field dependence, and science reasoning aptitude data were collected on the basis that they could provide evidence of their influence on the learning process taking place within the subjects as they participated in the treatments.

<u>Posttest</u>

Immediately upon completing the exhibit portion of the treatment all subjects were given a "free recall" test asking them to recall as much information about the exhibit as possible (Appendix J). Each recall test was judged on

the number of Zoology, Geology, or Unrelated/Other from the exhibit that were recalled. Inter-rater reliability between two judges after two trials was found to be 0.99 for Zoology rating, 0.97 for Geology rating, and 0.84 for the Unrelated/Other items rating of the free-recall measures.

In addition to the free recall measure, subjects received a 75 item written criterion measure (multiple choice answer) following their viewing of the treatment exhibit (Appendix K). One section of the test consisted of a total of 30 zoology questions, one section consisted of a total of 30 geology questions, and one section consisted of a total of 15 questions covering content that was not specific to either perspective but in the exhibit. Nineteen questions were also identified by museum staff as mainpoints that visitors should come away with to make the exhibit successful from their museum viewpoint. All questions were based on factual and conceptual recall of information from the exhibit. In order to avoid the potential effect of question order on subject recall, all 75 items on the instrument were randomly mixed. At the end of the criterion measure an 11 item survey instrument and a 25 item affective measure on the exhibit and museums was also included (Appendix L & M). The overall instrument (111 items) was designed for machine scoring. Subjects were provided with machine scorable answer sheets and instructed on their use.

Content validity was established by the researcher and museum staff who designed the exhibit. These judges compared the criterion measure items to the actual exhibit labels. Readability level of the test was set to meet that of the exhibit. The complete posttest instrument and treatment conditions were pilot tested for readability and difficulty with non-participating college students. Split half reliability (even/odd items) for the 75 item criterion referenced instrument (Y5--Total) was 0.86 on the pilot study with a K-R 20 of 0.77. Internal consistency for the same measure following the full study was 0.80 (K-R 20) and .90 (split half) on the study group. Based on these reliability estimates, Zoology (Y1), Geology (Y2), Unrelated/Other (Y3), and Mainpoint (Y4) questions were presumed to be randomly distributed throughout the instrument thus avoiding a cuing effect due to the order of the questions. All subscore measures (Y1-Y4) strongly correlate with the full 75 item criterion referenced instrument (Y5) as noted in Table 3-3. Reliability values for internal consistency of the subscore measures, although potentially misleading due to the low number of total items per subsection (15-30) and random placement of items on the main instrument, are listed in Table 3-3.

Table 3-3

Subscore and Total Score Correlations and Internal Consistency Reliabilities

Subscore Correlations with Full Criterion Referenced Instrument

	Y1 Zoology	Y2 Geology	Y3 Unrel./ Oth.	Y4 Mainpoint	Y5 Total
Y1	1.00	0.62	0.65	0.65	0.90
Y2	---	1.00	0.52	0.66	0.85
Y3	---	---	1.00	0.62	0.81
Y4	---	---	---	1.00	0.75
Y5	---	---	---	---	1.00

Reliabilities for Subscore and Total Score on Criterion Referenced Instrument

		Zoology (Y1)	Geology (Y2)	Unrelated (Y3)	Mainpoints (Y4)	Total (Y5)
Pilot (n=12)	split half (even/odd)	0.81	0.82	0.70	0.62	0.86
	K-R 20	0.63	0.56	0.42	0.54	0.77
Post-treatment (n=168)	split half (even/odd)	0.84	0.55	0.52	0.54	0.90
	K-R 20	0.64	0.53	0.52	0.46	0.80
	ave. item diff.	0.59	0.60	0.62	0.70	0.60
	ave. item disc.	0.32	0.29	0.42	0.32	0.29

General Procedures

Prior to initiating the study subjects were provided with a coded number used to assign them at random to treatments. The verbal ability and embedded figures aptitude measures, being timed measures, were administered to all of the subjects in a classroom setting prior to their participation in the experimental aspect of this study. For the experimental treatments, the exhibit panels and cases were labelled prior to subject arrival to the study site (Appendix G). Subjects were asked to report to the entry area of the museum where they were presented with the instructional brochure, instructed to read and follow the instructions carefully, and directed immediately to the experimental exhibit. All subjects were unobtrusively observed and timed by the researcher. Upon finishing their viewing of the exhibit, subjects were led to a location adjacent to the exhibit where they were given the post-test materials. No aspects of the study exhibit could be seen from the testing area. Subjects were instructed to complete the posttest materials in the order in which the measures were presented to them. They were instructed to complete the free recall instrument first followed by the 75 item criterion measure, the survey, the affective measure, and finally the ACT science reasoning test. No time limit was placed on the completion of the measures and the researcher carefully monitored the test area. The ACT instrument is

designed for a thirty minute time period; however due to the nature of this study subjects were allowed to work on the instrument for as long as they wished beyond the thirty minute time. Subjects were not rushed to finish but were monitored from a distance allowing them to work at their "leisure." Upon completion of their experience, subjects were asked to not discuss this experience with their peers should any be participating in this study.

Method of Analyses/Scoring

The data collected were analyzed using the multiple regression analysis for determining main effects, treatment effects, and aptitude treatment interactions. For the purposes of analysis the independent (X) variables included tests of verbal comprehension (X1), embedded figures (X2), and science reasoning skill (X3), as well as gender (X4), perspective (X5 & X6) and sequencing (X7) within the exhibit. The dependent (Y) variables were the sub-scores for Zoology (Y1), Geology (Y2), Unrelated/Other (Y3), and Mainpoint (Y4) and Total (Y5) scores on the criterion referenced measure posttest (cognitive) and the free recall test ratings (Y6 - Zoology--F.R., Y7 - Geology--F.R., Y8 - Unrelated/Other--F.R.). "Time in Exhibit" (Y10) is treated in this study as an additional dependent variable. In the case of the criterion measure each test was machine scored for Total score and sub-scores which were used in the

analysis. Total score for the criterion referenced instrument was a composite of the Zoology, Geology, and Unrelated/Other subscores. Unrelated/Other items is a category created for items that were based on exhibit content that was considered neither Zoology nor Geology in their content. Mainpoints is a category that consists of 19 points on the 75 item criterion referenced instrument that the museum staff felt would be the most important points they wished visitors would come away with from the exhibit.

As described previously, each subject's free recall measure was rated based on number of Zoology points, Geology points, and Unrelated/Other items points. In this case scores were determined through the use of judges who utilized the exhibit and the Zoologist and Geologist perspectives as the criteria for rating.

Although affective data were collected the focus of the analysis presented in this study is on the criterion referenced measure. The affective data, however, were used to provide descriptive information on those participating in this study.

CHAPTER 4
RESULTS

This study took place at the University of Florida Museum of Natural History between February and April of 1992. As the focus of this study is on the interaction between subject aptitudes, order of viewing a museum exhibit, and orienting instructions prior to viewing an exhibit it is important to review the following descriptive statistics on the criterion referenced outcome measure as well as on the subjects who participated in the study.

Criterion Referenced Outcome Measure

Content covered by the multiple choice instrument was distributed throughout the exhibit as noted in Table 4-1. It should be noted that the Zoology and Unrelated or Other content items were distributed more evenly throughout the exhibit. Efforts to completely cover the content of the exhibit were made however it is evident that the Geology information although present throughout the exhibit is more focused in certain locations. The relationship of this to the outcome will become more readily apparent in the discussion of the findings as they relate to the Geology

Table 4-1
Exhibit/Criterion Referenced Measure Content

Exhibit # in sequence	Zoology questions	Geology questions	Other questions	Final item numbers
1				
2	36,38,60	7,66	17,18,21	7,17,18,21,36,38,60,66
3		29,39,63		29,39,63
4	20,25	19		19,20,25,
5	62,72	4,70	12,18,48	4,12,18,48,62,70,72
6	54,62	6,9,26,30,55,59,61,67	14	6,9,14,26,30,54,55,59,61,67
7	23			23
8		22,27,32,43,49,58		22,27,32,43,49,58
9				
10	40,53,65	34	5,33	5,33,34,40,53,65
11				
12	47		10	10,47
13	11	42	50	11,42,50
14				
15	24,41,35		57,64,73	24,35,41,57,64,73
16	15,56	8,74	64	8,15,56,64,74
17	15,56,70		64	15,56,64,70
18	13,15,56,71		64	13,15,56,64,71
19	15,46,56		69,64	15,46,56,64,69
20	15,52,56		64	15,52,56,64
21	68,75			68,75
22	51		64	51,64
23			64	64
24	3,45			3,45
25				
26	37	74	1	1,37,74
27		2,16,28,31,42,44		2,16,28,31,44
TOTAL # questions	30	30	15	75

Final item key = underline - zoology; double underline - geology; normal - other; highlighted - **mainpoint**

subscore. Item difficulty or percentage of subjects scoring correctly on a particular question indicated that overall the instrument was moderately easy with only 25 items below the 0.50 difficulty level and 3 above the .90 level (Table 4-2). Difficulty of zoology, geology and unrelated items was evenly distributed with similar numbers of questions in each difficulty category (Table 4-3). Item difficulty, however, is hard to interpret as these difficulties are based on an overall analysis of the instrument across all questions and based on the combined effects of the treatment conditions. Internal consistency reliability (K-R 20) for the Total criterion referenced instrument was 0.80. As previously noted in Chapter 3 reliability estimates for each subsection, although potentially misleading due to the low numbers of items per subsection, range from 0.46 (Mainpoints--Y4) to 0.64 (Zoology--Y1).

Subjects--Descriptive Statistics

One hundred and sixty-eight college students from the University of Florida College of Education participated in this study. One hundred forty-four (85%) of the subjects were female and 24 (15%) were male. Subjects were predominantly juniors or seniors (93%) with only 5% being graduate students. Fifty-four percent of those participating in the study indicated that their major area

Table 4-2

Item Difficulty - 75 Item Criterion Referenced Measure

Item difficulty	Total Quest	Exhibit # in Sequence	Questions Number
0.91 - 1.0	3	2,5,7	23, 36, 70
0.81 - .90	10	2,3,5,6,10,12,16,21	6, 18, 34, 47, 60, 63, 64, 66, 67, 75
0.71 - .80	11	2,3,4,5,6,8,18,19,27	16, 20, 21, 31, 39, 43, 46, 48, 61, 62, 71
0.61 - .70	12	2,3,5,6,10,13,20,27	4, 9, 14, 26, 29, 38, 44, 50, 52, 53, 54, 72
0.51 - .60	14	2,5,8,10,13,15,19,26,27	1, 12, 15, 17, 24, 27, 28, 33, 41, 42, 56, 59, 69, 74
0.41 - .50	12	2,4,6,8,10,12,15,16,24,27	2, 3, 5, 7, 8, 10, 19, 22, 30, 55, 57, 73
0.31 - .40	5	5,8,10,18	13, 25, 40, 58, 65
0.21 - .30	3	15,22,26	35, 37, 51
0.11 - .20	5	8,13,21,24	11, 32, 45, 49, 68
0.00 - .10	0		
	75.00		

Final item key = underline - zoology; double underline - geology; normal - other; highlighted - **mainpoint**

Table 4-3

Summary of Item Difficulties by Zoology, Geology, Unrelated/Other, and Mainpoint Content

Difficulty	Number Zoology items	Number Geology items	Number Unrel./ Other items	Number Mainpoint items
> 0.90	3	0	0	2
0.51-0.89	16	20	11	14
< 0.50	11	10	4	3

of study was education followed by those reporting some other subject area (15%) other than english (13%), science (10%), or math (8%) as being their subject area of specialization. Subjects were predominantly between the age of 17 and 21 (72%) followed by those between 22 and 25 (20%). The majority of the subjects were white (88%) followed by Hispanic (7%) and African American (3%).

Museum visitation history of the subjects in this study is as follows. Sixty percent of the participants had not visited the Florida Museum of Natural History in the year prior to the study and 33% had visited on 1-2 occasions during the same time period. Forty eight percent of the participants had never visited the Florida Museum of Natural History and 78% indicated that they had never visited a natural history museum. When asked which museums they preferred to visit 33% indicated art museums, 31% indicated science museums and 28% indicated history museums. This visitation preference may be implied to have resulted from early childhood and adolescent experiences based on their responses to the question asking "if their parents took them to the museum as a child," 60% responded positively.

Subject area interest was also addressed both in the survey and affective measures used in this study. When asked whether they had visited or attended any museum, class presentation, or other activities related to fossils in the last year 70% indicated that they had not. Interest in

fossils remained high as 88% of the participants either strongly agreed (21%) or agreed (67%) with the statement that "Fossils are interesting to look at." At this point it should be reiterated that the affective portion of this study was completed following the completion of the treatments and all but the ACT science reasoning instrument. Prior knowledge regarding fossils may have been low as 84% indicated they either had no opinion (19%), disagreed (48%), or strongly disagreed (17%) with the statement that "I knew a lot about fossils before I came to this exhibit." Interest in the exhibit appears to have remained high as 92% of the participants indicated that they either strongly disagreed (34%), disagreed (49%), or had no opinion (9%) about the statement "The Florida fossil exhibit is boring." In fact, 61% of the subjects in this study either strongly agreed (5%) or agreed (56%) with the statement "I want to know more about fossils." Twenty-one percent indicated no opinion with respect to the latter statement.

With respect to the materials used in the study, the subjects appeared to be, at best, neutral (36% disagreed, 44% had no opinion and 20% agreed) when they responded to the statement "The orientation information received for this study helped me understand the fossil exhibit." This same trend carried through all of the treatment groups as indicated in Table 4-4.

Table 4-4

Replies by Treatment Group to Affect Item A22--"The orientation information received for this study helped me understand the fossil exhibit"

Treatment Conditions		Perspective Zoologist	Perspective Geologist	Perspective None
Sequence	1. strongly disagree	7%	7%	14%
	2. disagree	18%	21%	36%
	3. no opinion	50%	43%	36%
	4. agree	25%	29%	14%
	5. strongly agree	0%	0%	0%
Nonsequenced	1. strongly disagree	11%	11%	25%
	2. disagree	18%	32%	10%
	3. no opinion	57%	46%	36%
	4. agree	14%	11%	29%
	5. strongly agree	0%	0%	0%

Subject assignment to treatment conditions produced the following distribution: cell sizes ranged from 27 to 29 subjects per treatment and males were not well represented in the study as indicated in Table 4-5. The lack of sufficient numbers (2-7) of male subjects in the six treatment conditions precludes analysis of gender effects at the interaction level (discussed below), gender is however included in the overall model as a main effects variable. The student population of the University of Florida College of Education is, in fact, mostly female. Although this issue is foreseeable, literature previously cited indicated that males and females do behave differently in museum settings thus motivating the inclusion of this factor in the study.

Aptitude Measures--Descriptive Statistics

Overall unadjusted means for the verbal comprehension (VER) (X1), group embedded figures (GEFT) (X2), ACT science reasoning (ACT) (X3) and all outcome measures are noted on Table 4-6.

Means reported in the literature for the verbal comprehension measure range between 19.7 - 20.7 (SD 6.2 - 6.6) for H.S. graduates (Ekstrom et al., 1976) and 22.4 - 25.7 (SD 6.5 - 8.3) for college students (Peterson, 1979; Foster, 1991). The reported means for the group embedded figures measure range from 10.8 (females) to 12.0 (males)

Table 4-5

Gender of Subjects by Treatment Group

Treatments		Perspective - Zoologist	Perspective - Geologist	No perspective
Sequenced	female	22	26	25
	male	7	2	3
	total subjects	n=29	n=28	n=28
Nonsequenced	female	24	25	22
	male	4	3	5
	total subjects	n=28	n=28	n=27

overall n= 168

Table 4-6

Overall Unadjusted Means
ALL SUBJECTS - ALL APTITUDES - ALL OUTCOME MEASURES

Variable	N	Mean	Std Dev	Minimum /Maximum	Total Possible
Aptitudes					
X1--Verbal	168	25.7	6.31	6 - 41	48
X2--GEFT	168	12.2	4.29	0 - 18	18
X3--ACT	168	21.8	7.98	4 - 38	40
Outcomes					
Y1--Zoology	168	17.6	3.95	7 - 26	30
Y2--Geology	168	17.9	3.60	8 - 26	30
Y3--Unrelated	168	9.3	2.58	3 - 15	15
Y4--Mainpoints	168	13.4	2.58	6 - 19	19
Y5--Total	168	44.8	8.69	20 - 64	75
Y6--Zool.(Fr.Recall)	168	22.0	15.95	0 - 81	no upper limit
Y7--Geol.(Fr.R.)	168	11.9	7.63	0 - 38	no upper limit
Y8--Unrel.(Fr.R.)	168	3.4	3.63	0 - 17	no upper limit
Y9--Mainpts (Fr.R.)	168	3.5	1.84	0 - 10	no upper limit
Y10--Time in Exh.	168	40.7	11.63	7 - 72	no upper limit

(SD 4.1-4.2) (Witkin et al., 1971). Means for the ACT science reasoning measure are reported for high school graduates to be 17.48 (SD 4.32) and for college bound students as being 17.99 (SD 4.40) (ACT, 1989). Based on a scale reported by Lawson (1983) the GEFT mean score is indicative of a group that is field intermediate 7-12 (0-6 field dependent, 13-18 field independent). Higher means may be accounted for in the fact that the majority of the subjects were junior and senior level college students. The higher score on the ACT science reasoning measure is most likely due to both a reflection of the overall higher abilities of the subject group and the fact that on this measure subjects were allowed to work on the instrument beyond the 30 minute time period the instrument was designed for. This modification was made on the basis that museums are considered to be informal education settings where time limit, under normal circumstances, is established by the visitor to the particular institution. It should also be noted that in the case of the ACT measure a number of subjects became frustrated and gave up after the allocated 30 minute time period. Scores for these individuals were included in the analysis since under normal conditions the museum visitor determines the extent to which his/her efforts will be applied to gaining information or participating in a particular activity. No such options were available for the two former measures (VER and GEFT).

Unadjusted aptitude means by treatment condition can be noted in Table 4-7. As noted before gender differences in aptitudes are not discussed due to the insufficient number of volunteer male subjects.

The relationships between the aptitude measures and the outcome measures are indicated in Table 4-8. Verbal comprehension and ACT scores correlate significantly with each other which is to be expected as the ACT measure requires H.S. reading and comprehension skills. Verbal comprehension on the other hand appears to be weakly correlated with the Group Embedded Figures scores which would support the findings reported by Witkin et al. (1971, p. 7) that GEFT scores are a measure of "analytical and structuring abilities". This is further supported by a strongly significant relationship between ACT and GEFT scores. This relationship is to be expected as the ACT is designed to measure the "interpretation, analysis, evaluation, reasoning, and problem solving skills required in the natural sciences" (ACT, 1989, p. 19). There is a significant correlation ($p<0.05$) between verbal comprehension and outcome scores on the multiple choice and free recall measures. Time spent in the exhibit is weakly correlated with verbal comprehension as well as the ACT science reasoning. GEFT on the other hand strongly correlates with the multiple choice measure scores and shows no relationship with time or free recall scores. The ACT

Table 4-7

Unadjusted Means by Treatment Conditions
NO PERSPECTIVE AND NO SEQUENCE
(X5=0 X6=0 X7=0)

Variable	N	Mean	Std Dev	Minimum /Maximum	Total Possible
Aptitudes					
X1--Verbal	27	26.1	5.44	15-41	48
X2--GEFT	27	10.6	4.94	0-17	18
X3--ACT	27	20.1	7.85	4-37	40
Outcomes					
Y1--Zoology	27	17.2	4.37	8-26	30
Y2--Geology	27	16.8	4.28	9-26	30
Y3--Unrelated	27	8.6	2.79	3-15	15
Y4--Mainpoints	27	12.7	2.91	6-17	19
Y5--Total	27	42.4	9.99	23-62	75
Y6--Zool.(Fr.Recall)	27	18.2	10.29	2-49	no upper limit
Y7--Geol.(Fr.R.)	27	10.5	6.64	0-27	no upper limit
Y8--Unrel.(Fr.R.)	27	2.1	3.43	0-17	no upper limit
Y9--Mainpts (Fr.R.)	27	3.1	1.63	0-6	no upper limit
Y10--Time in Exhibit	27	37.4	11.98	7-60	no upper limit

NO PERSPECTIVE AND SEQUENCE
(X5=0 X6=0 X7=1)

Variable	N	Mean	Std Dev	Minimum /Maximum	Total Possible
Aptitudes					
X1--Verbal	28	25.6	5.71	17-39	48
X2--GEFT	28	11.9	4.36	3-17	18
X3--ACT	28	21.2	8.01	9-38	40
Outcomes					
Y1--Zoology	28	17.1	3.80	11-26	30
Y2--Geology	28	17.6	2.74	12-22	30
Y3--Unrelated	28	8.9	2.62	4-14	15
Y4--Mainpoints	28	13.3	1.86	10-16	19
Y5--Total	28	43.7	7.65	32-61	75
Y6--Zool.(Free Recall)	28	24.9	18.41	1-81	no upper limit
Y7--Geol.(Fr.R.)	28	12.5	8.58	0-38	no upper limit
Y8--Unrel.(Fr.R.)	28	4.9	3.94	0-16	no upper limit
Y9--Mainpts(Fr.R.)	28	3.7	1.76	1-7	no upper limit
Y10--Time in Exhibit	28	37.4	9.76	18-64	no upper limit

Table 4-7--continued

GEOLOGY PERSPECTIVE AND NO SEQUENCE
(X5=0 X6=1 X7=0)

Variable	N	Mean	Std Dev	Minimum /Maximum	Total Possible
Aptitudes					
X1--Verbal	28	26.8	5.70	13-36	48
X2--GEFT	28	12.4	3.96	5-18	18
X3--ACT	28	22.5	9.01	6-37	40
Outcomes					
Y1--Zoology	28	16.8	3.75	10-23	30
Y2--Geology	28	18.1	3.96	10-25	30
Y3--Unrelated	28	9.9	2.70	3-14	15
Y4--Mainpoints	28	13.2	3.05	6-18	19
Y5--Total	28	44.8	9.24	26-61	75
Y6--Zool.(Free Recall)	28	23.1	20.13	4-79	no upper limit
Y7--Geol.(Fr.R.)	28	12.8	9.16	0-35	no upper limit
Y8--Unrel.(Fr.R.)	28	3.1	3.59	0-13	no upper limit
Y9--Mainpts(Fr.R.)	28	3.0	1.67	0-6	no upper limit
Y10--Time in Exhibit	28	45.4	10.81	30-63	no upper limit

GEOLOGY PERSPECTIVE AND SEQUENCE
(X5=0 X6=1 X7=1)

Variable	N	Mean	Std Dev	Minimum /Maximum	Total Possible
Aptitudes					
X1--Verbal	28	26.9	6.27	9-40	48
X2--GEFT	28	12.1	4.52	3-18	18
X3--ACT	28	22.5	7.94	8-38	40
Outcomes					
Y1--Zoology	28	17.0	4.24	10-25	30
Y2--Geology	28	18.4	3.44	11-25	30
Y3--Unrelated	28	9.3	2.56	4-14	15
Y4--Mainpoints	28	13.9	2.38	10-19	19
Y5--Total	28	44.7	8.99	27-62	75
Y6--Zool.(Free Recall)	28	15.0	10.05	1-49	no upper limit
Y7--Geol.(Fr.R.)	28	12.6	7.80	3-36	no upper limit
Y8--Unrel.(Fr.R.)	28	3.2	3.28	0-10	no upper limit
Y9--Mainpts(Fr.R.)	28	3.8	1.99	0-10	no upper limit
Y10--Time in Exhibit	28	36.0	8.45	17-55	no upper limit

Table 4-7--continued

ZOOLOGY PERSPECTIVE AND NO SEQUENCE
(X5=1 X6=0 X7=0)

Variable	N	Mean	Std Dev	Minimum /Maximum	Total Possible
Aptitudes					
X1--Verbal	28	25.3	7.37	10-37	48
X2--GEFT	28	12.1	4.43	3-18	18
X3--ACT	28	22.4	7.98	9-37	40
Outcomes					
Y1--Zoology	28	19.5	2.76	14-24	30
Y2--Geology	28	18.4	3.25	14-26	30
Y3--Unrelated	28	10.2	2.23	5-15	15
Y4--Mainpoints	28	13.3	2.37	8-19	19
Y5--Total	28	48.1	7.08	37-64	75
Y6--Zool.(Free Recall)	28	28.6	16.21	0-67	no upper limit
Y7--Geol.(fr.R.)	28	11.9	6.31	1-26	no upper limit
Y8--Unrel.(Fr.R.)	28	4	2.79	0-10	no upper limit
Y9--Mainpts(Fr.R.)	28	3.6	2.04	0-7	no upper limit
Y10--Time in Exhibit	28	47.6	10.35	26-68	no upper limit

ZOOLOGY PERSPECTIVE AND SEQUENCE
(X5=1 X6=0 X7=1)

Variable	N	Mean	Std Dev	Minimum /Maximum	Total Possible
Aptitudes					
X1--Verbal	29	23.8	7.07	6-41	48
X2--GEFT	29	13.9	3.02	8-18	18
X3--ACT	29	22.1	7.49	5-36	40
Outcomes					
Y1--Zoology	29	18.1	4.24	7-26	30
Y2--Geology	29	18.1	3.83	8-25	30
Y3--Unrelated	29	9.2	2.36	5-14	15
Y4--Mainpoints	29	13.8	2.75	7-19	19
Y5--Total	29	45.4	8.67	20-59	75
Y6--Zool.(Free Recall)	29	22.1	15.31	0-67	no upper limit
Y7--Geol.(Fr.R.)	29	11.2	7.34	0-34	no upper limit
Y8--Unrel.(Fr.R.)	29	3.3	4.29	0-16	no upper limit
Y9--Mainpts(Fr.R.)	29	3.5	1.94	0-8	no upper limit
Y10--Time in Exhibit	29	40.3	13.55	14-72	no upper limit

Table 4-8

Correlations between Independent and Dependent Variables

Outcome measures → / Aptitudes	Zoology (Y1)	Geology (Y2)	Other (Y3)	Mainpts (Y4)	Total (Y5)	Zool. Fr. Recall (Y6)	Geol. Fr. Recall (Y7)	Other Fr. Recall (Y8)	Mainpts Fr. Recall (Y9)	Time (Y10)
Verbal Comp. (X1)	0.4661 * $p>0.0001$	0.4516 * $p>0.0001$	0.39279 $p>0.0001$	0.35944 $p>0.0001$	0.5140 * $p>0.0001$	0.1788 $p>0.0204$	0.1785 $p>0.0206$	0.0388 $p>0.6170$	0.1997 $p>0.0094$	0.1570 $p>0.0421$
Group Emb. Fig. (X2)	0.3534 * $p>0.0001$	0.2345 $p>0.0022$	0.2691 $p>0.0004$	0.2192 $p>0.0043$	0.3349 * $p>0.0001$	0.0605 $p>0.4354$	0.0423 $p>0.5854$	0.0178 $p>0.8182$	0.01523 $p>0.8447$	0.4975 $p>0.5220$
ACT (X3)	0.4824 * $p>0.0001$	0.4706 * $p>0.0001$	0.4426 $p>0.0001$	0.4259 * $p>0.0001$	0.5432 * $p>0.0001$	0.1631 $p>0.0346$	0.1417 $p>0.0669$	0.0835 $p>0.2815$	0.1369 $p>0.0767$	0.1952 * $p>0.0112$

* These relationships were found to be significant under regression analysis.

Table 4-9

Correlations between Independent Variables--
Verbal Comprehension, Group Embedded Figures, and ACT Measures

Aptitudes	Verb. Comp. (X1)	GEFT (X2)	ACT (X3)
Verbal Comprehension (X1)	1.00 0.0	0.15 0.0474	0.44 0.0001
Group Embedded Figures (X2)	—	1.00 0.0	0.30 0.0001
ACT (X3)	—	—	1.00 0.0

score is strongly correlated with scores on the multiple choice and free recall instruments as well as time spent in exhibit. Correlations such as those described above serve to indicate potential relationships between the aptitudes as well as between the outcome measures and aptitudes. Cells where regression analysis findings are significant are indicated on Table 4-8. It is readily evident that there is an overlap of findings, however it is also evident that a number of significant correlations are not confirmed as well as other non-significant correlations are found to be important through regression analysis. These discrepancies may be accounted for through the greater sensitivity of the regression analysis which is described in the following section. Correlation between the multiple choice outcome measure and verbal comprehension and the ACT science reasoning scores is not surprising in that information for the criterion referenced instrument was taken from the texts on the cases and panels thus relying strongly on the reading skills of the subjects. The free recall scores on the other hand tend to be weakly or moderately correlated with the aptitudes therefore implying that other factors may be at work (i.e. writing skills, organizational skills, etc.). The relationships discussed serve as indicators for the more comprehensive look at scores and their relationships to the variables discussed.

Regression Analysis

The function of regression analysis is to provide a better understanding of the relationship between a series of variables (X_1, X_2, . . . , X_n) and an outcome (Y) (Freund & Littell, 1991). The systematic variation in Y can be modeled as a function of X_1, X_2, . . . , X_n variables and is called the regression equation. This type of analysis allows one to estimate the conditional mean or predict individual scores. For this study the former is of interest. The conditional mean represents the mean for a homogeneous sub-population (treatment groups) on the dependent variable (Y). Actual outcome means (Tables 4-6 and 4-7) are composed of a number of effects including those of the aptitudes hypothesized to be related to the outcomes and the treatments to which the subjects are exposed to. Conditional means which are reported in the following discussion are therefore the outcomes that are adjusted to take into account the effect of the subject's abilities as indicated by the aptitude measures. The regression equation, which is an expression of the relationships hypothesized in this study, consisted of the variables as listed in Table 4-10. Residual plots were checked for violations of the assumptions of homoscedasticity (equal conditional variances) and linearity. No violations were

Table 4-10

Variables in the Regression Model

Independent Variables

Aptitudes

X1 = Verbal comprehension
X2 = Group embedded figures (GEFT)
X3 = Science reasoning (ACT)
X4 = Gender 0=female 1=male

Treatments

Perspectives

X5 = Zoologist categorical--coded
X6 = Geologist categorical--coded

Coding utilized for perspective

	X5	X6
Zoologist	1	0
Geologist	0	1
None	0	0

Sequence

X7 = Sequencing treatment--categorical coded
0 = no sequence
1 = sequenced

Dependent Variables

Outcomes

Y1 = Zoology score
Y2 = Geology score
Y3 = Unrelated/other score
Y4 = Mainpoints
Y5 = Total score
Y6 = Zoology rating--Free recall
Y7 = Geology rating--Free recall
Y8 = Unrelated/other rating--Free recall
Y9 = Mainpoints rating--Free recall
Y10 = Time in exhibit (minutes)

detected therefore analyses were run on the various outcome scores (Y1-Y10).

Findings

Statistical analyses were run on all outcome variables. Significant models ($p<0.05$) were found for Zoology subscore (Y1), Geology subscore (Y2), Unrelated/Other items subscore (Y3), Mainpoints score (Y4), Total score (Y5), Zoology Free Recall rating (Y6), and "Time in Exhibit" (Y10) (Table 4-11, Appendix N). Nonsignificant models were found for Geology Free Recall (Y7), Unrelated/other Free Recall (Y8), and Mainpoints Free Recall (Y9) (Appendix N). Significant findings are listed in Tables 4-11, 4-12 and 4-13. These findings are discussed in the following order: Zoology subscore (Y1), Geology subscore (Y2), Unrelated/Other subscore (Y3), Total score (Y5), Mainpoints score (Y4), Free Recall Zoology ratings (Y6), and Time in Exhibit (Y10). It should be recalled at this time that the Total score (Y5) on the criterion referenced measure is composed of the Y1, Y2, and Y3 subscores. Mainpoints (Y4) is a separate score of items on the criterion referenced measure.

Zoology Subscore (Y1)

The full regression model was significant ($F= 5.309$, $p>0.0001$) with the variables in the model explaining approximately 47% of the variance in the Y1 scores (Table 4-12, Appendix N). The verbal comprehension (X1), Group

Table 4-11

Summary of Significant Findings

Outcome measures → / Variables in model ↓	Zoology (Y1)	Geology (Y2)	Unrel/ Other (Y3)	Mainpts (Y4)	Total (Y5)	Zool. Fr. Recall (Y6)	Time (Y10)
Full model	*	*	*	*	*	*	*
Aptitudes							
Verbal compreh. (X1)	*	*			*		
GEFT (X2)	*				*		
ACT (X3)	*	*		*	*		*
gender (X4) (0=female 1=male)							*
Treatments							
persp zoology (X5=1 X6=0)	*	*		*	*		
persp geology (X5=0 X6=1)		*					
Test zool - geol (X5-X6)				*		*	
sequence (X7) (0=no seq 1=seq)		*			*		
Interactions - two way							
verb x zool (PR4)		*					
verb x geol (PR8)							
GEFT x zool (PR5)			*	*			
GEFT x geol (PR9)							
verb x seq (PR12)		*					
zool x seq (PR16)		*				*	
geol x seq (PR17)		*					
Interactions - three way							
verb x zool x seq (PR 18)		*		*			
verb x geol x seq (PR22)		*					
GEFT x zool x seq (PR19)							
GEFT x geol x seq (PR23)						*	

Significant findings based on $p < 0.05$(*).

Table 4-12
Criterion Referenced Outcome Measures--
Zoology, Geology, Unrelated/Other, and Total Scores--
Significant Findings

Outcome measures → / Variables in model ↓	Zoology (Y1)	Geology (Y2)	Unrel./ Other (Y3)	Total (Y5)
Full model	*	*	*	*
Aptitudes				
Verbal compreh. (X1)	(β= 0.27) *	(β= 0.39) *		(β= 0.81) *
GEFT (X2)	(β= 0.34) *			(β= 0.65) *
ACT (X3)	(β= 0.18) *	(β= 0.22) *		(β= 0.50) *
gender (X4) (0=female 1=male)				
Treatments				
persp zoology (X5=1 X6=0)	(β= 9.87) *	(β= 12.68)*		(β= 26.59)*
persp geology (X5=0 X6=1)	(β= 2.68)	(β= 9.47) *		(β= 13.92)
Test zool - geol (X5-X6)				
sequence (X7) (0=no seq 1=seq)		(β= 15.06)*		(β= 20.36)*
Interactions - two way				
verb x zool (PR4)		(β= -0.31) *		
verb x geol (PR8)		(β=-0.17)		
GEFT x zool (PR5)			(β= -0.30)*	
GEFT x geol (PR9)			(β=-0.01)	
verb x seq (PR12)		(β= -0.42) *		
zool x seq (PR16)		(β= -14.18)*		
geol x seq (PR17)		(β= -16.95)*		
Interactions - three way				
verb x zool x seq (PR 18)		(β= 0.55) *		
verb x geol x seq (PR22)		(β= 0.49) *		
GEFT x zool x seq (PR19)				
GEFT x geol x seq (PR23)				

Significant findings based on $p < 0.05$(*) with β indicating the direction of the slope of the regression line (change in Y for point of change in X).

Table 4-13

Criterion Referenced Outcome Measure--Mainpoints Score, Free Recall Zoology, and Time in Exhibit--Significant Findings

Outcome measures → / Variables in model ↓	Mainpts (Y4)	Zool. Fr. Recall (Y6)	Time (Y10)
Full model	*	*	*
Aptitudes			
Verbal compreh. (X1)			
GEFT (X2)			
ACT (X3)	(β= 0.14) *		(β= 0.61)*
gender (X4) (0=female 1=male)			(β= -5.81)*
Treatments			
persp zoology (X5=1 X6=0)	(β= 5.87) *		
persp geology (X5=0 X6=1)	(β= -1.87)		
Test zool - geol (X5-X6)	*	*	
sequence (X7) (0=no seq 1=seq)			
Interactions - two way			
verb x zool (PR4)			
verb x geol (PR8)			
GEFT x zool (PR5)	(β= -0.29)*		
GEFT x geol (PR9)	(β=0.07)		
verb x seq (PR12)			
zool x seq (PR16)		(β= -59.59)*	
geol x seq (PR17)		(β=2.97)	
Interactions - three way			
verb x zool x seq (PR 18)	(β= 0.36) *		
verb x geol x seq (PR22)	(β=0.10)		
GEFT x zool x seq (PR19)		(β=-0.20)	
GEFT x geol x seq (PR23)		(β= -3.38) *	

Significant findings based on $p < 0.05$(*) with β indicating the direction of the slope of the regression line (change in Y for point of change in X).

Embedded Figures (X2), and ACT science reasoning (X3) aptitudes were all positively related to zoology outcome scores. When controlling for all other factors zoology subscores rose from between 0.18 to 0.34 points for every point rise in ability level depending on the aptitude (Table 4-12). The higher the ability level of the subject on the particular aptitude the higher the subject's outcome score. As the ACT measure requires a "background knowledge at the level of a high school General Science course" it is evident from these results that the higher the science background of the subject the better the score (ACT, 1989, p.6). Gender was not found to be significant in relationship to outcome score.

Of the treatment conditions only the Zoologist perspective was found to be significant ($t= 2.49$, $p>0.01$). Subjects given the Zoologist perspective had subscores that were on the average 9.87 points higher than those with no perspective (Table 4-12). Although nonsignificant, subjects with Geologist perspectives scored on the average 2.68 points higher than those with no perspective. Differences between Zoologist and Geologist perspective outcomes were tested and found to be nonsignificant. Sequence was not found to be significant, however, subjects following the sequence instructions did score on the average 4.17 points higher than those who viewed the exhibit in random order. No interactions were found to be significant (Table 4-12).

Geology Subscore (Y2)

The full regression model was significant (F= 4.608, p>0.0001) with the variables in the model explaining approximately 44% of the variation in the Geology subscores (Table 4-11, Appendix N). The verbal comprehension (X1) and ACT science reasoning (X3) aptitudes were positively related to Geology outcome scores. Due to the significant interactions, interpretation of the significant effect for verbal ability must be conditioned on perspective and sequence. As with the Zoology subscore, higher prior science knowledge (ACT) by the subject results in a higher outcome on the Geology subscore. Gender was not found to be significant in relationship to the Geology subscore.

Significant interactions were found between verbal ability (X1), perspectives, and sequencing (Table 4-12). These interactions are depicted in Figure 4-1. When viewing the exhibit panels and cases in sequence the Geologist perspective-taking instructions appear to significantly hinder the acquisition of Geology information for both low and high ability subjects. Zoologist perspective-taking instructions, on the other hand, appear to be of equal value to low ability subjects as does no perspective. High ability subjects, however, appear to be able to better utilize the Zoologist perspective-taking instructions than the high ability no perspective subjects and both do better than those with the Geologist perspective.

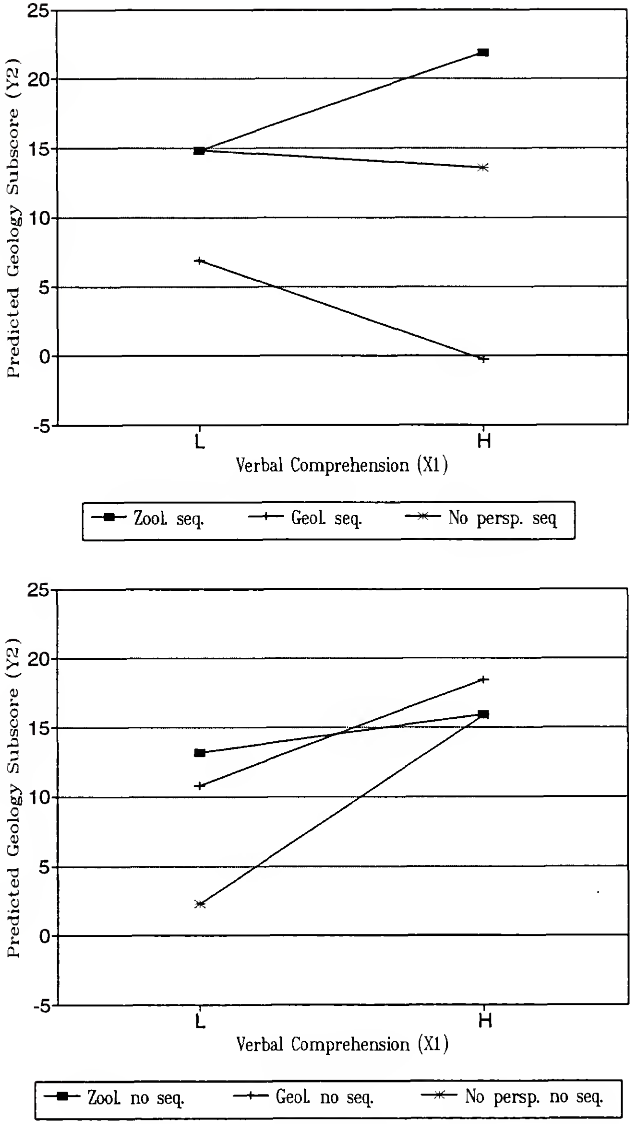

Figure 4-1. Three-way interaction between verbal comprehension, perspective, and sequence for predicted Geology subscore (Y2).
Upper figure = sequence treatment
Bottom figure = no sequence treatment

When viewing the exhibit under the no sequence condition the Geologist perspective again appeared to narrowly focus attention on information in the exhibit. Low ability subjects under the no sequence viewing order (random order) were able to capitalize on both the Geologist and Zoologist perspectives with the latter producing the highest results. High ability subjects, however, were better able to capitalize on the benefits of the Geologist perspective resulting in overall higher outcomes. Zoologist and no perspective high ability subjects although scoring higher than low ability subjects had effectively the same higher outcome scores on the Geology subscore. Overall high ability subjects were better able to capitalize on the perspectives under the no sequence condition whereas under the sequenced condition this effect was only present if they had the Zoologist perspective. Low ability subjects were also better able to capitalize on the perspective-taking instructions under the no sequence condition as opposed to those on the sequenced condition where they did not appear to benefit from any perspective. When controlling for all other variables, subjects viewing the exhibit in sequence scored significantly higher on the Geology subscore than those viewing it out of sequence. Similarly, subjects with Zoologist or Geologist perspectives scored significantly higher than those with no perspective. The difference

between Zoologist and Geologist perspective outcomes was tested and found to be nonsignificant.

Unrelated/Other Subscore (Y3)

As with the previously mentioned subscores the full model was found to be significant ($F=3.180$, $p>0.0001$) with the variables in the model explaining approximately 35% of the variation in the geology subscores (Tables 4-12, Appendix N). No significance was found for aptitudes other than that for the interaction of embedded figures with perspective-taking instructions (see Figure 4-2). High GEFT subjects with the Zoologist perspective did worse on the Other/unrelated items subscore than did those subjects with either Geologist or No perspective. For low GEFT subjects exactly the opposite is found. Low GEFT subjects with Zoologist perspective-taking instructions scored significantly higher than those with Geology or No perspective. These findings would appear to provide further evidence that attention and knowledge acquisition are being impacted by some aspect of the exhibit. The category of "Other/unrelated item" information in the exhibit is considered to be that information which is not clearly Zoology nor Geology but still found in the exhibit. For high GEFT subjects, attention may have been directed away from these points by the Zoologist perspective. The extensive Zoology content of the exhibit may in effect overwhelm the subject with this perspective leading high

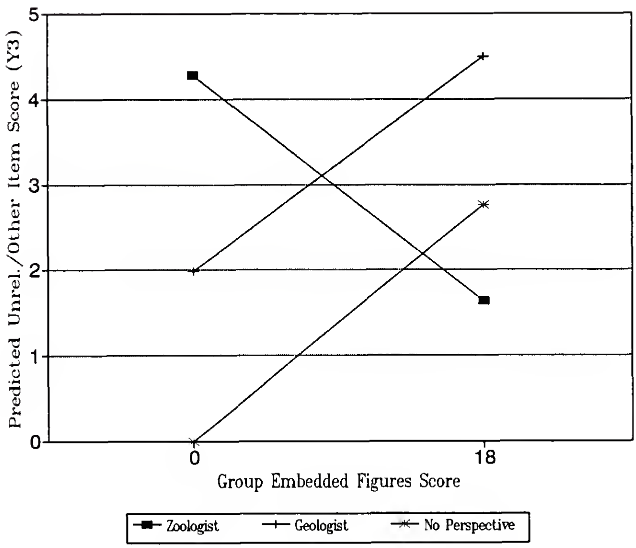

Figure 4-2. Two-way interaction between Group Embedded Figures and perspective for predicted Unrelated/Other subscore (Y3).

ability subjects to not attend to unrelated information. The finding that under the no perspective condition high ability subjects scored higher than low ability no perspective and high ability Zoologist perspective subjects suggests that this may be the case. On the other hand, the structure that the Zoologist perspective provides for a low ability subject appears to be beneficial. The Geologist perspective, although nonsignificant, appears to focus the attention of the subject more narrowly allowing him/her to pick up the unrelated information which may be associated with the areas on which attention is focused.

Total Score (Y5)

Total score (Y5) is composed of the Zoology, Geology, and Other subscores on the multiple choice or criterion referenced measure. For this outcome the full regression model was significant ($F= 6.364$, $p>0.0001$) with the variables in the model explaining approximately 52% of the variation in the Y5 scores (Table 4-12, Appendix N). The verbal comprehension (X1), Group Embedded Figures (X2), and ACT science reasoning (X3) aptitudes were all positively related to the Total outcome score (Table 4-8 and 4-12). When controlling for all other factors Total scores rose from between 0.50 to 0.81 points for every point rise in ability level (Table 4-12). As noted for the Zoology subscore the higher the ability level of the subject on the particular aptitude the higher the subject's outcome score.

Background science knowledge as represented by the ACT Science Reasoning measure was again found to be a significant determinant of outcome. Gender was not found to be significant in relationship to Total outcome score.

Of the treatment conditions only the Zoologist perspective was found to be significant ($t= 3.196$, $p>0.002$). When controlling for other variables, subjects viewing the exhibit with the Zoologist perspective had Total scores that were on the average 26.59 points higher than those with no perspective (Table 4-12 and 4-14). Although nonsignificant, subjects with Geologist perspectives scored on the average 13.92 points higher than those with no perspective. Differences between Zoologist and Geologist perspective-taking outcomes were tested and found to be nonsignificant. Sequence was found to be significant, with subjects who viewed the exhibit in sequence scoring on the average 20.36 points higher than those who viewed the exhibit at random. For Total Score (Y5), no interactions were found to be significant (Table 4-12).

<u>Mainpoints Score (Y4)</u>

Mainpoints addresses the minimal information that the museum staff felt that a visitor should know after visiting the exhibit. For this outcome the full regression model was significant ($F= 3.35$, $p>0.0001$) with the variables in the model explaining approximately 36% of the variation in the Y4 scores (Table 4-13, Appendix N). The ACT Science

Table 4-14

Main Effect Mean Differences for Total Score by Treatment

	Zoologist perspective	Geologist perspective	No perspective	Significant Sequence effect
Sequence	46.95	34.28	20.36	20.36
No Sequence	26.59	13.92	0.00	0.00
Significant perspective effect	26.59	ns	0.00	----

Reasoning (X3) aptitude measure was the only aptitude measure that was significantly related to Mainpoints outcome scores as a main effect. When controlling for all other factors Mainpoints scores rose 0.14 points for every point rise in science reasoning ability (Table 4-13). Again as noted previously background science knowledge as represented by the ACT Science Reasoning measure was again found to be a significant determinant of outcome. Gender was not found to be significant in relationship to the Mainpoints outcome score.

Significant interactions were found between verbal ability, Zoologist perspective-taking and sequencing as well as between Group Embedded Figures and Zoologist perspective-taking (see Figures 4-3 and 4-4 respectively). Under the sequenced condition, high verbal ability subjects were able to capitalize on the Zoologist perspective-taking instructions and attain higher mainpoint scores. Under the No sequence condition high verbal ability subjects with Zoologist perspective-taking instruction were unable to capitalize significantly on the instructions and in fact appear to be hindered in some way. Overall subjects with the Zoologist perspective under the sequenced condition outscored all other treatment conditions regardless of verbal ability. Under both the sequence and no sequence conditions low verbal ability Zoologist perspective-taking subjects were apparently able to capitalize on the

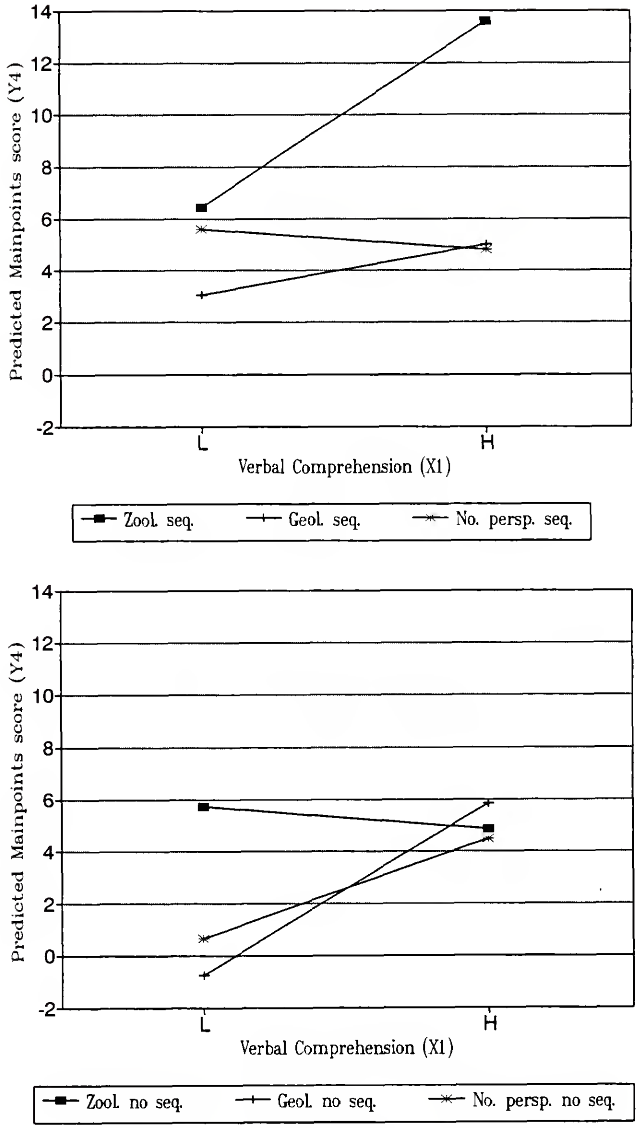

Figure 4-3. Three-way interaction between verbal comprehension, perspective and sequence for predicted Mainpoints score (Y4).
Upper figure = sequence treatment
Bottom figure = no sequence treatment

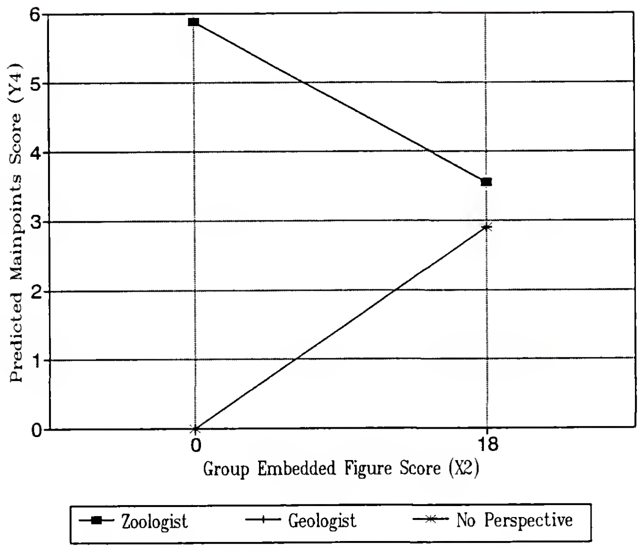

Figure 4-4. Two-way interaction between Group Embedded Figures and perspective for predicted Mainpoints score (Y4).

perspective beyond that of the Geologist and no perspective subjects. A similar pattern is evident in the finding that Geologist perspective-taking subjects with low verbal ability following the sequenced conditions scored higher on mainpoints than Geologist/no sequence subjects.

With respect to GEFT interaction with perspective, it appears that the Zoologist perspective negatively impacted the outcome of those with high GEFT, whereas the Geologist and No perspective conditions were at best equal in outcome. Low GEFT individuals, on the other hand, appear to have benefitted from the Zoologist perspective thus acquiring a higher number of mainpoints.

Zoology Free Recall Rating (Y6)

The free recall instrument was rated for total number of zoology, geology and other points written down by the subjects. The zoology free recall rating is a total score for each subject that represents the total number of zoology related items that the subject remembered after viewing the exhibit. For this outcome measure the full regression model was significant ($F=1.68$, $p>0.033$) with the variables in the model explaining approximately 22% of the variance in the Y6 scores (Table 4-13, Appendix N).

Significant differences were found between the Zoologist and Geologist perspectives as well as interactions between Group Embedded Figures, Geologist perspective and sequence and between Zoologist perspective and sequence (see

Figure 4-5). Under the sequenced condition those subjects with Geologist or No perspective were able to recall significantly more Zoology points than subjects with the Zoologist perspective, regardless of their GEFT level. Subjects given the Zoologist perspective had the lowest recall of Zoology free recall points under the sequenced condition with high GEFT individuals recalling more than those of low GEFT. These findings under the sequenced condition are completely reversed under the no sequenced condition. Subjects with the Zoologist perspective performed better overall on recall of Zoology points under the no sequence condition. High GEFT subjects although recalling more Zoology points than other subjects recalled less points than those of low GEFT using the Zoologist perspective. Low GEFT subjects with the Geologist perspective, however, did significantly worse overall followed by those with no perspective. High GEFT subjects using the Geologist perspective on the other hand did significantly better than those with no perspective. High GEFT subjects given the Zoologist perspective although doing better than all other perspective conditions scored lower than their low GEFT counterparts. As in previous findings perspectives appears to be differentially affecting subject attention and recall. No aptitudes were found to be significantly predictive of Free Recall outcome.

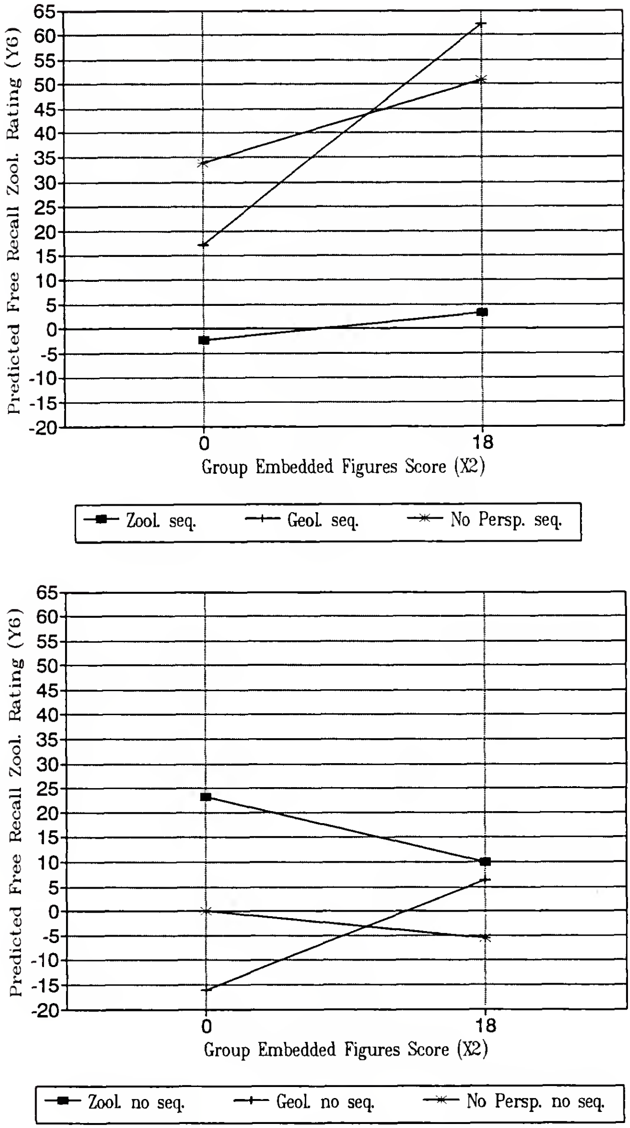

Figure 4-5. Three-way interaction between Group Embedded Figures, perspective, and sequence for predicted Free Recall Zoology rating (Y6). Upper figure = sequence treatment Bottom figure = no sequence.

Time in Exhibit (Y10)

For this outcome the full regression model was significant (F= 2.732, p>0.0001) with the variables in the model explaining approximately 31% of the variation in the Y10 scores (Table 4-13, Appendix N). The ACT Science Reasoning (X3) aptitude was the only aptitude measure significantly predictive of Time in Exhibit outcome. When controlling for all other factors Time in Exhibit rose 0.61 minutes for every point rise in ACT ability level. Background science knowledge as represented by the ACT Science Reasoning measure was again found to be a significant determinant of outcome. Gender was also found to be a significant aptitude in relationship to the Time spent in exhibit outcome. Confirming findings of other researchers males were found to spend on the average six (5.81) minutes less than females in the exhibit when controlling for all other variables in the model.

Nonsignificant Findings

Free Recall Geology, Other, and Mainpoint ratings regression models were found to be nonsignificant at the alpha 0.05 level (F=0.827, p>0.70; F=0.92, p>0.57; and F=0.94, p>0.55, respectively) (Appendix N). These findings are not totally unexpected as the free recall instructions were nonfocusing and allowed subjects to recall whatever they could remember about the exhibit and as little or as

much as they wished therefore introducing a high degree of variance into the instrument.

These nonsignificant findings may be positive results in the sense that they correspond with the findings on the criterion referenced instrument that the Zoologist perspective condition was significant both for the Total outcome score and the Zoology and Geology outcome subscores as well as the Mainpoints scores.

Hypotheses

As will be recalled the following eight research hypotheses, stated in the null form, were tested using multiple regression analysis. The findings from the test of each hypothesis are as follows:

Main Effects

Hypothesis 1. No relationship exists between the aptitudes (verbal comprehension, embedded figures, and science reasoning skill) and the posttest scores (Y1 through Y10).

Finding 1. On the basis of evidence previously presented this hypothesis is rejected. Verbal comprehension, embedded figures and ACT Science Reasoning aptitudes were positively and significantly related to outcome scores on the criterion referenced post test. The ACT Science Reasoning score was positively related to five of the post tests (Total score and Zoology/Geology

subscores, Mainpoints score and Time in Exhibit) whereas verbal comprehension was on three (Zoology/Geology subscores, and Total scores). Group Embedded Figures score was positively related to outcome on two outcome measures (Zoology subscore and Total score).

Hypothesis 2. No relationship exists between gender and the posttest score (Y1 through Y10).

Finding 2. This hypothesis is rejected on the basis that gender was significantly related to Time spent in exhibit score. No significance was found between gender and posttest scores other than Time in Exhibit. These nonsignificant findings regarding the relationship between gender and other posttest scores must be interpreted on the basis of the limitations placed on the analysis by the low numbers (2-7) of male subjects in each treatment condition.

Hypothesis 3. No relationship exists between perspective and posttest score (Y1 through Y10).

Finding 3. This hypothesis is rejected on the basis of the finding that the Zoologist perspective was significant on the Total score as well as the Zoology and Geology subscores, and the Mainpoints score. The post test differences between those using the Zoologist and Geologist perspective were significant on the Zoology Free Recall post test.

Hypothesis 4. No relationship exists between sequence and posttest score (Y1 through Y10).

Finding 4. This hypothesis is rejected on the basis that sequence was significantly related to outcome score on the Geology subscore and Total score.

Two-way Interactions

Hypothesis 5. The relationship of perspective to the posttest (Y1 through Y10) score does not differ by sequence.

Finding 5. This hypothesis is rejected on the basis of the finding that Geology subscores and Zoology Free Recall scores differed as to whether the subjects viewed the exhibit in sequence or with no sequence using the Zoologist, Geologist, or No perspective taking instructions.

Hypothesis 6. The relationship of aptitude (verbal comprehension, embedded figures, and science reasoning skill) on posttest score (Y1 through Y10) does not differ by perspective.

Finding 6. This hypothesis is rejected on the basis of significant findings of interactions between verbal comprehension and the Zoologist perspective on the Geology subscore. Furthermore, support for rejecting this hypothesis is also found in the finding of interaction between Group Embedded Figures and Zoologist perspective for the Other subscore and Mainpoints score. Gender was not included as an aptitude due to the lack of sufficient male subjects as discussed previously.

Hypothesis 7. The relationship of aptitude (verbal comprehension, embedded figures, and science reasoning skill) on the posttest score does not differ by sequence.

Finding 7. This hypothesis is rejected on the basis of significant interactions between verbal ability and sequence for the Geology subscore post test. Gender was not included as an aptitude due to the lack of sufficient male subjects as discussed previously.

Three-way Interaction

Hypothesis 8. The relationship of aptitude (verbal comprehension, embedded figures, and science reasoning skill) with the posttest does not differ by the combined effects of sequence and perspective.

Finding 8. On the basis of the evidence from the Geology subscore and Total score this hypothesis is rejected. The overall effect of aptitudes plus the combined effects of sequence and perspectives were found to produce significant effects as evidenced by the outcome scores. Subjects of differing verbal comprehension ability had differing outcomes based on the Zoologist, Geologist, and NO perspective and sequence conditions. The ACT Science Reasoning Measure although contributing to the full models did not produce any interaction effects. Gender was not included as an aptitude due to the lack of sufficient male subjects as discussed previously.

Review of Findings

All null hypotheses are rejected on the basis of the findings of this study. The relationship between the aptitudes, treatment conditions, and posttest scores is a complex one with no single outcome measure providing enough evidence to singularly reject the various hypotheses.

CHAPTER 5
DISCUSSION AND IMPLICATIONS

As will be recalled the problems to be explored in this study were as follows:

(a) to what extent is exhibit sequence important in the acquisition of cognitive and affective material in the exhibit?

(b) to what extent can learners be influenced by perspective taking instructions given prior to visiting an exhibit? and

(c) to what extent do visitor characteristics such as verbal ability, field dependence/independence, and general science knowledge interact with learner acquisition of cognitive and affective exhibit outcomes?

In effect this study was designed to provide insight into exhibit design based on what visitors need to know and do in order to learn from an exhibit.

These questions rest in part on the following theoretical directions discussed in Chapter 2.

a. Museum exhibits are designed with some form of structure and sequence in mind (Lakota, 1975;

Lakota & Kantner, 1976; Miles et al., 1988; Neal, 1976; Screven, 1968, 1969).

b. It is easier to attend to information if the visitor can find some means of organizing the information. Awareness of sequence and structure is important in providing learners with context of the information to be learned - "ideational anchorage" (Alt & Griggs, 1984; Anderson, 1970, 1977, 1984; Ausubel & Fitzgerald, 1962; Briggs, 1967; Gagne, 1970, 1985; Gagne & Driscoll, 1988; Koran, Koran & Foster, 1989; Lakota, 1976; Meyers, Pezdek, & Coulson, 1973; Patten, Chao, & Reigeluth, 1986; Reigluth, Merrill, & Bunderson, 1978; Shuell, 1986; Wilson & Koran, 1976; etc.).

c. Attention directing devices such as perspectives, cuing strategies, directions, advance organizers provide learners with ways of accessing existing strategies, knowledge, information and memory structures, etc. (Anderson, Pichert, & Shirey, 1983; Bransford & Johnson, 1973; Fitzgerald, 1962; Frase, 1970; Mayer, 1979; Pichert & Anderson, 1977; Rothkopf, 1970; Screven, 1974; Stronck, 1983; Wilson & Koran, 1976; Wittrock, 1978; etc.).

The unifying design across all of these theoretical dimensions is that the learner should have the essential or previously learned prerequisite knowledge or skill that

facilitate the learning process (C.D.T., 1976; Lakota & Kantner, 1976). Outcome variations then occur on the basis of the individual differences in cognitive capacity, prior knowledge, verbal and spatial ability, and mode of instruction. These variations in outcome as evidenced by the results previously presented provide the basis for the following discussion.

To What Extent is Exhibit Sequence Important in the Acquisition of Cognitive and Affective Material in the Exhibit?

Results of this study provide supporting evidence that the sequence in which a subject views an exhibit significantly affects cognitive outcomes. The content of the experimental exhibit was organized in such a way that when a viewer entered he/she began by defining the concept "fossil" in text and through the presentation of a variety of examples. This case is followed by a clear representation of the process by which fossils are formed and so on. Subjects viewing the exhibit in the designed sequence scored over 20 points higher than those viewing the exhibit at random. Such findings are in line with research findings of Lakota and Kantner (1976) and Miles et al. (1988). This progression from simple concepts to the more complex ones is also consistent with learning process and instructional design theory as proposed by authors such as Gagne (1970, 1985), Gagne, and Driscoll (1988), and Wilson

and Koran (1976). By providing the viewer with the prerequisite knowledge to understand much of the information in other areas of the exhibit the curators and designers have significantly enhanced the potential outcome of the visitor experience. By making the visitor aware of this sequence the visitor is free to step into the exhibit at whatever level of understanding desired. If the exhibit sequence is followed, perception is enhanced and encoding is assured.

If the museum experience is enhanced on a cognitive level one would surmise that the affective outcomes will also be impacted. This area however was not investigated by this study. A positive overall attitude across all subjects was noted in that a majority of the subjects reported that they agreed or strongly agreed with the statement "I want to know more about fossils". With low knowledge and prior visitation being a beginning characteristic it can be surmised that participation in this study was fundamentally a positive experience as the response to the previously mentioned statement was made after viewing the exhibit. By being aware of the intended viewing order visitors then have the opportunity to organize the information in a way that should be interesting to them.

To What Extent can Learners be Influenced by Perspective-Taking Instructions Given Prior to Visiting an Exhibit?

Main effect findings support the conclusion that perspective-taking instructions given prior to viewing an exhibit can influence learner cognitive outcome. It is also evident from the findings of this study that the effects of these instructions are clearly interlinked with the ability levels of the individual museum visitor. The differences in outcome between the Zoologist/Geologist/No perspective, however, may be the result of the effectiveness of the perspective structure, the relationship to exhibit content, and the nature of visitor characteristics. The findings regarding these combined effects are discussed below.

It is evident from the findings of this study that perspective-taking instructions focus attention and may both assist as well as hinder a visitor to an exhibit.

In this study the overall cognitive outcome was significantly higher for those using only one of the perspectives, that of a Zoologist. Although the outcome results for those using the Geologist perspective were not found to be significant, subjects did score higher on the overall outcome measure than those with no perspective at all. These findings provides further evidence that perspective-taking instructions may have the function of providing the learner with an "ideological scaffold" to use in relating to the subject at hand (Anderson, Reynolds,

Schallert, & Goetz, 1977b; Pichert & Anderson, 1977). In fact the data also appear to provide further evidence that the strength of a particular perspective may be such that individuals may focus their attention to such an extent that they do not attend to other information at hand. The Zoologist perspective is a case in point. The data suggest that this perspective did focus attention for high GEFT ("analytical" ability) individuals in such a way that these subjects may have reduced their attention to the unrelated information in the exhibit. Whereas those with the Geologist perspective performed significantly better on the unrelated items. Anderson and Pichert's (1978) conclusion that some irrelevant information is encoded during information processing is supported by these findings with respect to unrelated items. Under these conditions, the learner searches the range of information provided by the exhibit and in so doing focus' on, and encodes, a variety of irrelevant information because he/she does not know positively what constitutes relevant information.

Findings suggest that Geologist perspective-taking instructions may serve to focus subject attention in such a way that it may interfere with the acquisition of geology facts when used under the sequenced condition. This is supported by the fact that the no perspective and Zoologist perspective conditions revealed a higher Geology subscore. Alternatively, subjects might find the Geologist perspective

so difficult or unclear that it did not help them. On the other hand, under the no sequence condition high ability subjects were better able to use the Geologist perspective whereas low ability subjects were better able to capitalize on both. These findings would indicate that high ability subjects were able to fill in the "gap" in their geology knowledge base without the assistance of structure. Viewing the exhibit in sequence provided the needed structure for the lower ability subjects to do so. This finding is consistent with previously reviewed research which shows that structure and sequence may well interfere with the attentional and processing activities of high ability students, but assists low ability students.

Similar findings occurred under both sequenced and nonsequenced conditions with regards to mainpoints recall items. Those subjects with the Zoologist perspective did better overall and "Geologist" low ability did better than high ability subjects. In looking at the GEFT low ability did better with the Zoologist perspective and high ability worse.

These findings along with the findings that the outcome differences for subjects of different verbal ability were significant suggests that as previously noted attention may be either narrowly focused or interfered with. The perspectives appear to act differentially under the different sequencing conditions, Geologist--producing the

lowest mainpoint scores for persons with low ability following the sequenced as well as no sequence condition. For high ability individuals this difference is such that those with the Zoologist perspective acquire more mainpoints under the sequence condition than all other subjects.

Another explanation for these findings may be related to the perceived value of the material as well as interest of the subject in the material (Shirey & Reynolds, 1988). Subjects may have found the zoology information more interesting and thus allocated extra attention to such information in the exhibit. Further, the variations may indicate that the subjects did not have a pre-existing knowledge base of Geology but may have in Zoology, therefore the information not related to geology was easier to process and recall.

A secondary and perhaps more plausible explanation is that those subjects with Zoology perspectives converged their attention on the zoology information and coded it more efficiently causing them to overlook the unrelated information.

The overall ineffectiveness of the Geologist perspective is perhaps explained by the high probability that subjects may not have had the prior knowledge to be able to utilize the perspective to create the "scaffolding" needed in order to properly acquire the information at hand. The Geologist perspective may in fact have required a higher

level of specialized knowledge. If this prerequisite knowledge is not present the perspective will not result in the desired outcome. This hypothesis would be suggested by the Geology subscore (Y2) outcome findings under the Geologist/Sequenced condition where those with the Geology perspective performed significantly worse than those with Zoology or no perspective. Again evidence supporting this conclusion has been presented by Grabe (1979) who reported that in the case of using the homebuyer perspective, some students were unable to use it due to a lack of the necessary knowledge required to organize the perspective since few had ever been homebuyers. As previously noted these findings may provide further support for the assimilation process for knowledge acquisition suggested by Mayer and Bromage (1980).

An overriding conclusion is evident in these findings suggesting that subjects experienced some form of interference in their ability to attend and retain the information in the exhibit. This interference functioned selectively for high and low ability subjects, confronted with the Zoologist or Geologist perspective under sequenced or unsequenced conditions. The researcher was unable to pinpoint the mechanism of this interference.

To What Extent do Visitor Characteristics such as Verbal Ability, Field Dependence/Independence, and General Science Knowledge Interact with Learner Acquisition of Cognitive and Affective Exhibit Outcomes?

Finding for the Geology subscore Geologist/No Sequence condition suggests that a factors in addition to those mentioned above may be involved in these findings. The Zoologist perspective takers under the sequenced condition were perhaps better able to structure their knowledge due to both their familiarity with the subject and the organizational "scaffold" provided by the exhibit. Low verbal comprehension ability subjects with the Geologist perspective under the No sequence condition, however, were apparently able to better utilize the organizational framework the perspective provided than those with no perspective but not as strongly as those with the Zoologist perspective. In this case the perspective provided the subject with the structure needed to compensate for the lack of sequence. The negative influence of the Zoologist perspective for high verbal comprehension subjects suggests another factor may be at play in these findings. The findings from other subscores indicates that the Zoologist perspective is one that provides the subject with a familiar schema with which to link what they learn and recall from the exhibit. On the Geology subscore those high verbal comprehension ability individuals may have been hindered by the Zoologist schema to the point that they appear to have

been no better off than the No perspective group. A similar effect appears to be present for the "Mainpoints" score. Under the Sequenced condition the Geologist perspective scores were significantly lower for both ability levels on verbal comprehension and were significantly higher for the high ability level group under the No Sequence condition. The presence of an interfering factor is also supported by a finding that the high ability GEFT subjects using the Zoologist perspective had a lower understanding of "Mainpoints" and that those with Geologist perspective had no better score than those with the No perspective condition.

What this interference is can only be surmised, however the exhibit has as a major focus "Fossils" in the initial cases/panels and what appears to be a major Zoology component from the outset. Although the Geology information is found throughout the exhibit, it's emphasis begins at panel six and following panel eight is again fairly subtle and mixed into the subject as one moves through the exhibit. Under the sequence condition the preliminary exhibit information focuses attention on "zoology" related information which is exactly the opposite of how attention is focused under the no sequence condition. The Geology information should therefore be easier to attend to under the No sequence condition as the subjects are not required to attend to the sequenced instructional material format of

the exhibit. It is then predictable that the findings would suggest that the Geologist perspective works under the very limited conditions reported above. The exhibit designers intent of providing the visitor with Geology information may be ineffective due to the lack of prior knowledge of geology by the viewer and to the lack of sufficient preparatory material in the exhibit itself.

The finding that the ACT Science Reasoning test was a significant predictor of outcomes on Zoology (Y1), Geology (Y2), Total (Y5), Mainpoints (Y4), and Time spent in the exhibit (Y10) and did not interact lends support to the prior knowledge arguments above. Across all of the outcome measures mentioned above, those that performed well on the ACT measure scored higher in each of the content areas measures (zoology, geology, etc.). As can be recalled this measure is based on high school science knowledge and skills needed to understand science. Furthermore, those who scored higher on the ACT spent more time in the exhibit (Y10). This evidence strongly supports the prior knowledge conclusions made above and the recommendations to be made in the following section.

Implications

The findings of this study suggest that there is ample evidence for providing visitors with tools which they may interpret an exhibit. This procedure is easier, cheaper and

more expedient than redesigning and refurbishing exhibits to accommodate visitors. Furthermore there is ample evidence to suggest that visitors who are provided with some way to organize their knowledge upon entry into the exhibit will come away from the exhibit with a greater understanding of the subject matter or content of the exhibit. The key to this lies in making and/or providing the proper linkages to preexisting knowledge structures within the visitor that allow the visitor to both utilize as well as enhance any prior knowledge base. How could these findings be implemented?

In designing and building an exhibit all attempts should be made to carefully sequence the content and, most importantly, to direct the visitors attention to that sequence. Assumptions that visitors have the prerequisite knowledge should be avoided and pilot studies should be conducted to determine the "knowledge structures" or schema as well as learning devices (such as perspectives, questions, etc.) that should be incorporated into the exhibit. A variety of "learning" options at the entry of the exhibit should be provided which the visitor can select from. These options should take into account the variety of ability levels and each should allow the visitor to capitalize on his/her particular skills. Under optimal circumstances such choices might also induce a visitor to

try new approaches and perhaps even begin to assimilate new knowledge and skills.

Existing exhibits could be enhanced by the addition of panels or brochures that give directional as well as content information. Obviously this information would have to minimally provide the structural (sequence) information and logic behind the organization of the content. New exhibits should, at a minimum, incorporate into them the fundamental information a viewer would need to have in order to understand the concepts displayed. This does not necessarily mean that the information should not require the visitor to come to his/her own conclusions. A series of questions with directions on how to get to the answer, questions with short answers with linking directions to other broader information, etc. would provide most visitors with at least the basic organizational information needed to understand the exhibit. Specially prepared perspectives, presented in a brochure/handout format, could mobilize visitor knowledge and prepare the visitor to learn from the exhibit. Needless to say this structure would be available for the visitor to choose to use.

This study and its findings suggest that it is cheaper, easier, and more expedient to adapt existing exhibits to visitors by using orienting information such as perspectives rather than engaging in great cost to revise exhibits to adapt them to visitors. Certainly, a mix of approaches to

orient visitors would optimize the value of new and existing exhibits to the visitor.

The finding reported on here also offer implications for further study. Gender related museum learning issues were not addressed by this study due to the low numbers of males in the subject pool. However, males did spend significantly less time in the exhibit than females. It would be misleading to discuss this finding until further data from future studies with larger samples of male subjects become available.

It is evident from this study that museums under all circumstance should attempt to facilitate the museum experience and the interaction between the visitor and exhibits. Any attempts should be properly evaluated and implemented on the basis of pilot studies and evidence of the functionality of the methods to be implemented. Visitor characteristics such as verbal, perceptual style, and analytical ability as well as prior knowledge will have as much impact on the museum experience as the same characteristics of the museum professional have on the exhibit when it is being designed and constructed.

APPENDIX A
SAS RANDOM NUMBERS PROGRAM
FOR ASSIGNMENT TO TREATMENT CONDITIONS

```
DATA SUBJECT;
INPUT Y;
* PERSPECTIVE 1 = ZOOLOGY;
* PERSPECTIVE 2 = GEOLOGY;
* PERSPECTIVE 3 = NO PERSPECTIVE;
* ORDER 1 = SEQUENCED VIEWING;
* ORDER 2 = RANDOM - NON SEQUENCED VIEWING;
* Y IS THE SUBJECT IDENTIFICATION NUMBER USED TO ASSIGN TO
TREATMENT/CONTROL;
X=RANUNI (0);
PERSP = 2;
IF X<.3334 THEN PERSP = 1;
IF X>.6668 THEN PERSP = 3;
ORDER = 1;
IF X>.1667 AND X<.3333 THEN ORDER = 2;
IF X>.5001 AND X<.6668 THEN ORDER = 2;
IF X>.8335 THEN ORDER = 2;
CARDS;
1        22        43        64        85        106
2        23        44        65        86        107
3        24        45        66        87        108
4        25        46        67        88        109
5        26        47        68        89        110
6        27        48        69        90        111
7        28        49        70        91        112
8        29        50        71        92        113
9        30        51        72        93        114
10       31        52        73        94        115
11       32        53        74        95        116
12       33        54        75        96        117
13       34        55        76        97        118
14       35        56        77        98        119
15       36        57        78        99        120
16       37        58        79        100       121
17       38        59        80        101       122
18       39        60        81        102       123
19       40        61        82        103       124
20       41        62        83        104       125
21       42        63        84        105       126
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127	169
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153	195
154	196
155	197
156	198
157	199
158	200
159	PROC
160	PRINT;
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162	
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165	
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167	
168	

PROGRAM PRINTOUT--SUBJECT RANDOM NUMBERS ASSIGNMENT

OBS	Y	X	PERSP	ORDER
1	1	0.431776	2	1
2	2	0.705024	3	1
3	3	0.970592	3	2
4	4	0.342315	2	1
5	5	0.772171	3	1
6	6	0.194201	1	2
7	7	0.277112	1	2
8	8	0.910486	3	2
9	9	0.947379	3	2
10	10	0.594698	2	2
11	11	0.730927	3	1
12	12	0.808972	3	1
13	13	0.831516	3	1
14	14	0.879331	3	2
15	15	0.911209	3	2
16	16	0.301182	1	2
17	17	0.698110	3	1
18	18	0.503995	2	2
19	19	0.228698	1	2
20	20	0.864699	3	2
21	21	0.126627	1	1
22	22	0.202450	1	2
23	23	0.984910	3	2
24	24	0.216485	1	2
25	25	0.392650	2	1
26	26	0.732828	3	1
27	27	0.464098	2	1
28	28	0.058538	1	1
29	29	0.497315	2	1
30	30	0.403440	2	1
31	31	0.259223	1	2
32	32	0.931966	3	2
33	33	0.859854	3	2
34	34	0.246171	1	2
35	35	0.930298	3	2
36	36	0.590562	2	2
37	37	0.149594	1	1
38	38	0.881935	3	2
39	39	0.233205	1	2
40	40	0.633578	2	2
41	41	0.248508	1	2
42	42	0.334178	2	1
43	43	0.563673	2	2

OBS	Y	X	PERSP	ORDER
44	44	0.180976	1	2
45	45	0.641523	2	2
46	46	0.270405	1	2
47	47	0.465510	2	1
48	48	0.723890	3	1
49	49	0.458574	2	1
50	50	0.011541	1	1
51	51	0.106384	1	1
52	52	0.454680	2	1
53	53	0.429878	2	1
54	54	0.042025	1	1
55	55	0.676620	3	1
56	56	0.690433	3	1
57	57	0.036626	1	1
58	58	0.651065	2	2
59	59	0.278083	1	2
60	60	0.897360	3	2
61	61	0.000875	1	1
62	62	0.232545	1	2
63	63	0.763884	3	1
64	64	0.936149	3	2
65	65	0.077164	1	1
66	66	0.250856	1	2
67	67	0.507565	2	2
68	68	0.964054	3	2
69	69	0.021240	1	1
70	70	0.551455	2	2
71	71	0.920834	3	2
72	72	0.446245	2	1
73	73	0.877747	3	2
74	74	0.154198	1	1
75	75	0.961506	3	2
76	76	0.729616	3	1
77	77	0.496872	2	1
78	78	0.685294	3	1
79	79	0.502551	2	2
80	80	0.773478	3	1
81	81	0.819566	3	1
82	82	0.830458	3	1
83	83	0.582189	2	2
84	84	0.512752	2	2
85	85	0.649049	2	2
86	86	0.062135	1	1
87	87	0.884570	3	2
88	88	0.044645	1	1

OBS	Y	X	PERSP	ORDER
89	89	0.778610	3	1
90	90	0.132951	1	1
91	91	0.625730	2	2
92	92	0.877285	3	2
93	93	0.588525	2	2
94	94	0.794115	3	1
95	95	0.799116	3	1
96	96	0.600655	2	2
97	97	0.755794	3	1
98	98	0.046650	1	1
99	99	0.622187	2	2
100	100	0.456363	2	1
101	101	0.818818	3	1
102	102	0.932887	3	2
103	103	0.773292	3	1
104	104	0.981244	3	2
105	105	0.056234	1	1
106	106	0.517090	2	2
107	107	0.686302	3	1
108	108	0.959196	3	2
109	109	0.175442	1	2
110	110	0.114399	1	1
111	111	0.089196	1	1
112	112	0.600876	2	2
113	113	0.564351	2	2
114	114	0.484178	2	1
115	115	0.051561	1	1
116	116	0.820364	3	1
117	117	0.517272	2	2
118	118	0.359446	2	1
119	119	0.336494	2	1
120	120	0.400940	2	1
121	121	0.417139	2	1
122	122	0.810289	3	1
123	123	0.373050	2	1
124	124	0.046784	1	1
125	125	0.550617	2	2
126	126	0.674150	3	1
127	127	0.964156	3	2
128	128	0.675132	3	1
129	129	0.855722	3	2
130	130	0.272506	1	2
131	131	0.467603	2	1
132	132	0.621080	2	2
133	133	0.901586	3	2

OBS	Y	X	PERSP	ORDER
134	134	0.894821	3	2
135	135	0.551163	2	2
136	136	0.272185	1	2
137	137	0.909747	3	2
138	138	0.720581	3	1
139	139	0.026785	1	1
140	140	0.070370	1	1
141	141	0.301690	1	2
142	142	0.812117	3	1
143	143	0.548285	2	2
144	144	0.195133	1	2
145	145	0.192779	1	2
146	146	0.176767	1	2
147	147	0.270481	1	2
148	148	0.400564	2	1
149	149	0.139165	1	1
150	150	0.932092	3	2
151	151	0.468256	2	1
152	152	0.892673	3	2
153	153	0.209197	1	2
154	154	0.153626	1	1
155	155	0.233782	1	2
156	156	0.149288	1	1
157	157	0.521320	2	2
158	158	0.080872	1	1
159	159	0.052936	1	1
160	160	0.808091	3	1
161	161	0.777220	3	1
162	162	0.272665	1	2
163	163	0.337265	2	1
164	164	0.609231	2	2
165	165	0.500594	2	2
166	166	0.062463	1	1
167	167	0.909661	3	2
168	168	0.248246	1	2
169	169	0.094489	1	1
170	170	0.294330	1	2
171	171	0.800483	3	1
172	172	0.899577	3	2
173	173	0.351943	2	1
174	174	0.474686	2	1
175	175	0.548716	2	2
176	176	0.788818	3	1
177	177	0.546516	2	2
178	178	0.797001	3	1

OBS	Y	X	PERSP	ORDER
179	179	0.882169	3	2
180	180	0.718813	3	1
181	181	0.688977	3	1
182	182	0.053799	1	1
183	183	0.657501	2	2
184	184	0.193177	1	2
185	185	0.100253	1	1
186	186	0.147459	1	1
187	187	0.011787	1	1
188	188	0.401990	2	1
189	189	0.306934	1	2
190	190	0.763699	3	1
191	191	0.865215	3	2
192	192	0.307998	1	2
193	193	0.680637	3	1
194	194	0.452220	2	1
195	195	0.881612	3	2
196	196	0.806928	3	1
197	197	0.846407	3	2
198	198	0.579088	2	2
199	199	0.426337	2	1
200	200	0.687983	3	1

	ORDER 1 (SEQUENCED)	ORDER 2 (RANDOM)
PERSP 1	33 (1-1)	31 (1-2)
PERSP 2	29 (2-1)	32 (2-2)
PERSP 3	40 (3-1)	35 (3-2)

APPENDIX B
CRITERION REFERENCED MEASURE ITEM ORDER

Random Numbers listing for assigning test items to final numerical sequence.

1 SAS 11:04 THURSDAY, DECEMBER 26, 1991 1

OBS	Y	X
1	1	0.423617
2	2	0.762764
3	3	0.455152
4	4	0.292191
5	5	0.204259
6	6	0.953566
7	7	0.781481
8	8	0.691734
9	9	0.229454
10	10	0.681281
11	11	0.789939
12	12	0.479289
13	13	0.133288
14	14	0.233019
15	15	0.491447
16	16	0.417759
17	17	0.721611
18	18	0.177027
19	19	0.931952
20	20	0.940903
21	21	0.149461
22	22	0.534236
23	23	0.657743
24	24	0.986574
25	25	0.893736
26	26	0.643374
27	27	0.521620
28	28	0.064848
29	29	0.452222
30	30	0.551464
31	31	0.824654
32	32	0.118156
33	33	0.786473
34	34	0.469022
35	35	0.342597

OBS	Y	X
36	36	0.202209
37	37	0.125722
38	38	0.866338
39	39	0.294044
40	40	0.764689
41	41	0.114349
42	42	0.496936
43	43	0.217815
44	44	0.081429
45	45	0.576973
46	46	0.396666
47	47	0.721215
48	48	0.496421
49	49	0.514777
50	50	0.298296
51	51	0.361026
52	52	0.182793
53	53	0.982718
54	54	0.391480
55	55	0.760168
56	56	0.741695
57	57	0.296104
58	58	0.347999
59	59	0.121921
60	60	0.047808
61	61	0.215920
62	62	0.136804
63	63	0.197549
64	64	0.187136
65	65	0.163345
66	66	0.392670
67	67	0.084206
68	68	0.974942
69	69	0.731284
70	70	0.913478
71	71	0.622684
72	72	0.008718
73	73	0.788681
74	74	0.128334
75	75	0.571636

Random Number sequence for final test construction OBS = number for assignment and Y = the test number prior to assignment.

1 SAS 11:04 THURSDAY, DECEMBER 26, 1991 3

OBS	Y	X
1	72	0.008718
2	60	0.047808
3	28	0.064848
4	44	0.081429
5	67	0.084206
6	41	0.114349
7	32	0.118156
8	59	0.121921
9	37	0.125722
10	74	0.128334
11	13	0.133288
12	62	0.136804
13	21	0.149461
14	65	0.163345
15	18	0.177027
16	52	0.182793
17	64	0.187136
18	63	0.197549
19	36	0.202209
20	5	0.204259
21	61	0.215920
22	43	0.217815
23	9	0.229454
24	14	0.233019
25	4	0.292191
26	39	0.294044
27	57	0.296104
28	50	0.298296
29	35	0.342597
30	58	0.347999
31	51	0.361026
32	54	0.391480
33	66	0.392670
34	46	0.396666
35	16	0.417759
36	1	0.423617
37	29	0.452222
38	3[illegible]	0.455152
39	34	0.469022
40	12	0.479289
41	15	0.491447
42	48	0.496421

OBS	Y	X
43	42	0.496936
44	49	0.514777
45	27	0.521620
46	22	0.534236
47	30	0.551464
48	75	0.571636
49	45	0.576973
50	71	0.622684
51	26	0.643374
52	23	0.657743
53	10	0.681281
54	8	0.691734
55	47	0.721215
56	17	0.721611
57	69	0.731284
58	56	0.741695
59	55	0.760168
60	2	0.762764
61	40	0.764689
62	7	0.781481
63	33	0.786473
64	73	0.788681
65	11	0.789939
66	31	0.824654
67	38	0.866338
68	25	0.893736
69	70	0.913478
70	19	0.931952
71	20	0.940903
72	6	0.953566
73	68	0.974942
74	53	0.982718
75	24	0.986574

APPENDIX C
EXHIBIT LABELLING
SEQUENCE ASSIGNMENT

1 SAS 11:01 WEDNESDAY, DECEMBER 25, 1991 1

OBS	Y	X	Sequenced	Random
1	1	0.525527	A	17
2	2	0.284329	B	8
3	3	0.721527	C	21
4	4	0.049861	D	1
5	5	0.297734	E	9
6	6	0.497286	F	14
7	7	0.558765	G	18
8	8	0.495226	H	12
9	9	0.752954	I	23
10	10	0.497285	J	13
11	11	0.743401	K	22
12	12	0.138327	L	6
13	13	0.503287	M	15
14	14	0.256386	N	7
15	15	0.067860	O	3
16	16	0.399292	P	10
17	17	0.802816	Q	26
18	18	0.063091	R	2
19	19	0.778572	S	25
20	20	0.665588	T	19
21	21	0.081586	U	4
22	22	0.465271	V	11
23	23	0.110316	W	5
24	24	0.699542	X	20
25	25	0.776014	Y	24
26	26	0.860506	Z	27
27	27	0.522409	AA	16

SAS RANDOM NUMBER GENERATION PROGRAM FOR EXHIBIT SEQUENCE ASSIGNMENT

```
DATA EXHIBIT;
INPUT Y;
X=RANUNI (0);
CARDS;
1
2
3
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PROC PRINT;
```

APPENDIX D
FOSSIL STUDY CENTER SEQUENCE OF EXHIBIT PANELS AND CASES

1. Fossil Object Case

2. What are fossils panel
One case with examples: cave breccia, gastroliths, amber, etc.

3. How are fossils formed panel

4. Rhino bed fossil case

5. What do fossils tell us panel that includes photos

6. What are dinosaurs and why don't you find dinosaurs in Florida panel

7. Adjacent Tyrannosaurus rex skull case

8.. Geological time scale panel

9. Fossil column

10. What did Florida look like 50 million years ago panel
One case: Florida's oldest vertebrate fossil, Basilasaurus cetoides fossils, seagrass fossil

11. Seabed fossils case: misc corals and shells

12. Nautiloid case

13. Whale case

14. Forest setting fossils case: Amphicyon, Archaeohippus, Prosynthetoceros, Floridatragulus, Parahippus

15. Parahippus leonencis case (skeleton plus model and label)

16. Introduction to Forest-Grassland diorama

17. Pseudoceros (deer skeleton plus model and label)

18. _Thinobadistes sequis_ (ground sloth skeleton plus model and label)

19. _Barbourofelis lovei_ (sabretooth cat skeleton plus model and label)

20. _Teleoceras proterum_ (rhinoceros skeleton plus model and label)

21. _Geocheloni hoyi_ (tortoise shell plus model and label)

22. _Gavialosuchus americanus_ (narrow-snouted crocodile fossil skeleton plus model and label)

23. Embedded fossil remains of 22 and 23

24. _Metaxytherium floridanum_ (sea cow fossil skeleton plus model and label)

25. Shell bed column

26. Shell bed panel and case

27. Global warming panel

END OF EXHIBIT

APPENDIX E
SUBJECT INSTRUCTION SHEETS
ZOOLOGIST/SEQUENCED
Visitor Instructions

Individuals who view exhibits appear to be able to take the viewpoint of some fictional character or individual. By using this viewpoint some parts of the exhibit appear more important than others. When visiting the exhibit in this study you are to take the following perspective:

Pretend you are a ZOOLOGIST as you view the panels and objects in this exhibit. You are interested in learning facts, concepts, and relationships from the fossils in the exhibit. A ZOOLOGIST is a person who studies animal life and animals, both as individuals and classes of the animal kingdom (such as Class Mammalia). A ZOOLOGIST looking at the exhibit would focus attention on the common and scientific names of fossilized animals (such as *Mammuthus columbi* (Columbian mammoth)), on where animals lived, on what animals fed on, on the general characteristics of animals such as size and their relationship to other species, on environmental conditions (such as climate) that might affect animal species, and on other information that may give clues to the identity and habits of fossilized animal species. Your task is to view the exhibit from the point of view of the ZOOLOGIST and remember as much as a ZOOLOGIST would about the exhibit.

When viewing the exhibit BEGIN WITH THE PANEL OR CASE LABELED A THEN GO IN THE EXACT ORDER TO B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, AND AA (end).

If you need directions let the monitor know. You may NOT go back to any previous exhibit in the sequence which you are following. Do NOT talk with any of your classmates who may be viewing the exhibit at this time. You may take as much time as you need. See the monitor when you finish viewing the exhibit.

(NOTE: These instructions have been reduced from actual character size Times - 12 point)

GEOLOGIST/SEQUENCED

Visitor Instructions

Individuals who view exhibits appear to be able to take the viewpoint of some fictional character or individual. By using this viewpoint some parts of the exhibit appear more important than others. When visiting the exhibit in this study you are to take the following perspective:

Pretend you are a GEOLOGIST as you view the panels and objects in this exhibit. You are interested in learning facts, concepts, and relationships from the fossils in the exhibit. A GEOLOGIST is a person who studies rocks, rock layers, and rock deposits (such as sedimentary rock, lava, limestone, etc.), and the geological time periods of earth's history as recorded in rocks (i.e. the Cambrian Period represents 65 to 70 million years ago). A GEOLOGIST looking at the exhibit would focus attention on periods of time, on the processes leading to the formation of rock layers and fossils (such as weathering, etc.), on the fossils associated with the various rock layers and geologic time periods, and on information on environmental conditions (such as temperature, moisture, etc.) that may be inferred from rocks and rock layers of a given date or time period. Your task is to view the exhibit from the point of view of the GEOLOGIST and remember as much as a GEOLOGIST would about the exhibit.

When viewing the exhibit BEGIN WITH THE PANEL OR CASE LABELED A THEN GO IN THE EXACT ORDER TO B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, AND AA (end).

If you need directions let the monitor know. You may NOT go back to any previous exhibit in the sequence which you are following. Do NOT talk with any of your classmates who may be viewing the exhibit at this time. You may take as much time as you need. See the monitor when you finish viewing the exhibit.

(NOTE: These instruetions have been reduced from character size Times - 12 point)

NO PERSPECTIVE/SEQUENCED

Visitor Instructions

Individuals who view exhibits appear to be able to take the viewpoint of some fictional character or individual. By using this viewpoint some parts of the exhibit appear more important than others.

When viewing the exhibit in this study you are to try to learn as much as you can from the exhibits in this exhibit hall.

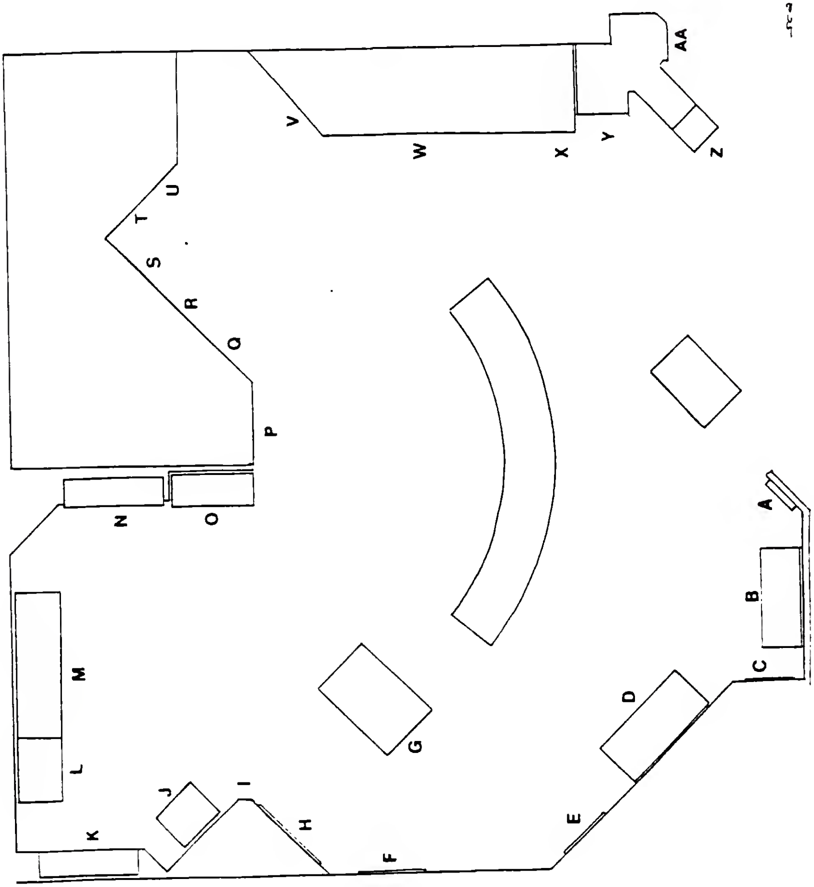
When viewing the exhibit BEGIN WITH THE PANEL OR CASE LABELED A THEN GO IN THE EXACT ORDER TO B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, AND AA (end).

If you need directions let the monitor know. You may NOT go back to any previous exhibit in the sequence which you are following. Do NOT talk with any of your classmates who may be viewing the exhibit at this time. You may take as much time as you need. See the monitor when you finish viewing the exhibit.

(NOTE: These instructions have been reduced from character size Times - 12 point)

SEQUENCED MAP

Reduced from actual size (8.5"x11") utilized during the study. Floorplan sketch provided by Dorr Dennis, exhibit designer, Florida Museum of Natural History.



APPENDIX F
SUBJECT INSTRUCTION SHEETS
ZOOLOGIST/NON-SEQUENCED

Visitor Instructions

Individuals who view exhibits appear to be able to take the viewpoint of some fictional character or individual. By using this viewpoint some parts of the exhibit appear more important than others. When visiting the exhibit in this study you are to take the following perspective:

Pretend you are a ZOOLOGIST as you view the panels and objects in this exhibit. You are interested in learning facts, concepts, and relationships from the fossils in the exhibit. A ZOOLOGIST is a person who studies animal life and animals, both as individuals and classes of the animal kingdom (such as Class Mammalia). A ZOOLOGIST looking at the exhibit would focus attention on the common and scientific names of fossilized animals (such as *Mammuthus columbi* (Columbian mammoth)), on where animals lived, on what animals fed on, on the general characteristics of animals such as size and their relationship to other species, on environmental conditions (such as climate) that might affect animal species, and on other information that may give clues to the identity and habits of fossilized animal species. Your task is to view the exhibit from the point of view of the ZOOLOGIST and remember as much as a ZOOLOGIST would about the exhibit.

When viewing the exhibit BEGIN WITH THE PANEL OR CASE LABELED 1 THEN GO IN THE EXACT ORDER TO 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, AND 27 (end).

If you need directions let the monitor know. You may NOT go back to any previous exhibit in the sequence which you are following. Do NOT talk with any of your classmates who may be viewing the exhibit at this time. You may take as much time as you need. See the monitor when you finish viewing the exhibit.

(NOTE: These instructions have been reduced from character size Times - 12 point)

GEOLOGIST/NONSEQUENCED

Visitor Instructions

Individuals who view exhibits appear to be able to take the viewpoint of some fictional character or individual. By using this viewpoint some parts of the exhibit appear more important than others. When visiting the exhibit in this study you are to take the following perspective:

Pretend you are a GEOLOGIST as you view the panels and objects in this exhibit. You are interested in learning facts, concepts, and relationships from the fossils in the exhibit. <u>A GEOLOGIST is a person who studies rocks, rock layers, and rock deposits (such as sedimentary rock, lava, limestone, etc.), and the geological time periods of earth's history as recorded in rocks (i.e. the Cambrian Period represents 65 to 70 million years ago)</u>. <u>A GEOLOGIST looking at the exhibit would focus attention on periods of time, on the processes leading to the formation of rock layers and fossils (such as weathering, etc.), on the fossils associated with the various rock layers and geologic time periods, and on information on environmental conditions (such as temperature, moisture, etc.) that may be inferred from rocks and rock layers of a given date or time period</u>. Your task is to view the exhibit from the point of view of the GEOLOGIST and remember as much as a GEOLOGIST would about the exhibit.

When viewing the exhibit BEGIN WITH THE PANEL OR CASE LABELED 1 THEN GO IN THE EXACT ORDER TO 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, AND 27 (end).

If you need directions let the monitor know. You may NOT go back to any previous exhibit in the sequence which you are following. Do NOT talk with any of your classmates who may be viewing the exhibit at this time. You may take as much time as you need. See the monitor when you finish viewing the exhibit.

(NOTE: These instructions have been reduced from character size Times - 12 point)

NO PERSPECTIVE/NONSEQUENCED

Visitor Instructions

Individuals who view exhibits appear to be able to take the viewpoint of some fictional character or individual. By using this viewpoint some parts of the exhibit appear more important than others.

When viewing the exhibit in this study you are to try to learn as much as you can from the exhibits in this exhibit hall.

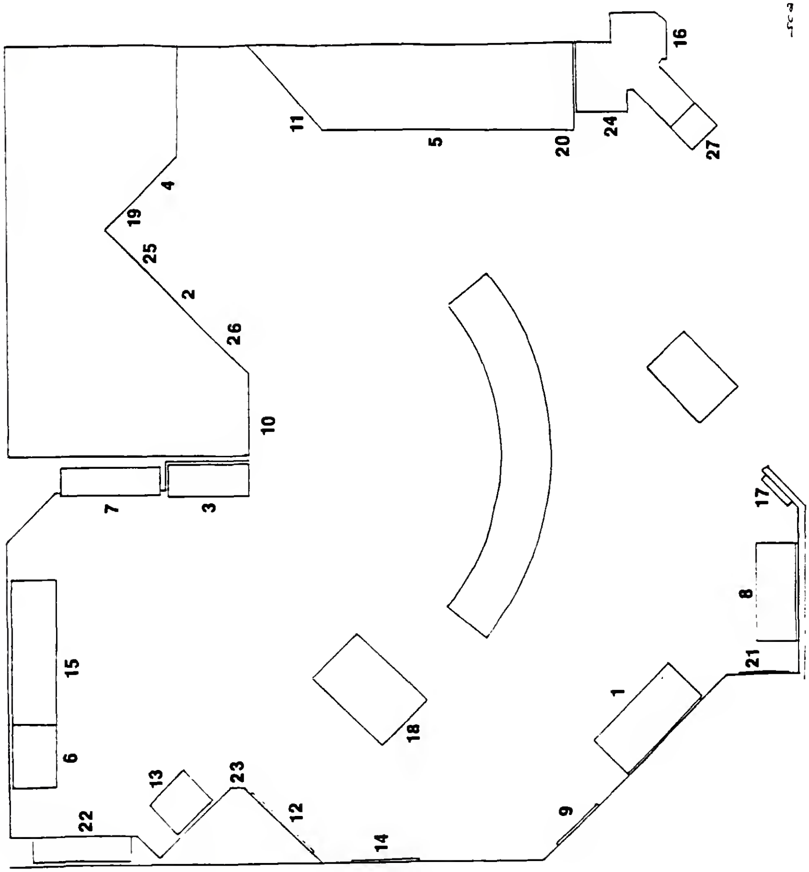
When viewing the exhibit BEGIN WITH THE PANEL OR CASE LABELED 1 THEN GO IN THE EXACT ORDER TO 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, AND 27 (end).

If you need directions let the monitor know. You may NOT go back to any previous exhibit in the sequence which you are following. Do NOT talk with any of your classmates who may be viewing the exhibit at this time. You may take as much time as you need. See the monitor when you finish viewing the exhibit.

(NOTE: These instructions have been reduced from character size Times - 12 point)

NONSEQUENCED MAP

Reduced from actual size (8.5"x11") utilized during the study. Floorplan sketch provided by Dorr Dennis, exhibit designer, Florida Museum of Natural History.



APPENDIX G
SAMPLE OF EXHIBIT/CASE LABEL

A

17

APPENDIX H
INTRODUCTORY PROJECT INFORMATION FOR SUBJECTS

Project Description for Subjects

Introductory Project Description for Volunteers:
Museum Learning Research
January through April, 1992

This research study is being conducted as part of a doctoral dissertation in Museum Studies, College of Education, University of Florida. Subjects volunteering for this study are guaranteed anonymity. The purpose of this study is to better understand museum exhibits and their design. Subjects can expect to be tested during the study. It should be understood, however, that the results of these activities will have no impact on the subjects and at best should provide the subject with an interesting experience. When you volunteer for this study you will be given a randomly assigned number which you must use throughout the study. You may be asked to participate in at least two session - each lasting no longer than two hours. Upon signing up you will be provided with a schedule of activities and requested to provide a time period when you will be available.

Should you desire to participate please contact Jim Ellis at 392-9191 (messages) (mailbox 258 Norman) or at 332-3806 (home) or the project faculty advisor - Dr. John J. Koran, Jr., professor science education and museum studies, College of Education, 392-9191 x268, 305 Norman Hall.

APPENDIX I
SUBJECT INFORMED CONSENT RELEASE FORM

Volunteer Written Informed Consent Form

This research study is being conducted as part of a doctoral dissertation which has been reviewed and approved by the University of Florida Institutional Review Board. Subjects volunteering for this study are guaranteed anonymity. The purpose of this study is to better understand museum exhibits and their design. Volunteers can expect to be tested during the study. It should be understood, however, that the results of these activities will have no impact on the subjects and at best should provide the subject with an interesting experience.

When you volunteer for this study you will be given a randomly assigned number which you must use throughout the study. You will be asked to participate in at least two sessions - each lasting no longer than two hours.

I hereby acknowledge receiving and reading a copy of the project description and agree to participate in the study.

Student____
Date____________________ Contact phone number____________

I agree to keep all participant information anonymous and confidential.

Researcher ________________________________
James F. Ellis, Jr.

Date_____________ Contact phone 904-392-9191 (x 268)
904-332-3806 (home)

Faculty advisor: Dr. John J. Koran, Jr., Professor Science Education and Museum Studies, College of Education, University of Florida.

Subject Number Assigned______________________

APPENDIX J
FREE RECALL MEASURE

Subject Identification Number ______ DATE ______ TIME ______

Free Recall Measure

Please write down as many points as you can remember about the exhibit. Use the back of the page as needed.

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2.____
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8.____
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Side 2 - Recall - Subject Identification Number______

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(NOTE: Reduced form font size Times 12.)

APPENDIX K
CRITERION REFERENCED OUTCOME MEASURE AND ANSWER KEY

Actual font size of instrument Times 12. Coding added for purpose of this printing: Z= Zoology item, G= Geology item, O= Other item, bold = Mainpoint item, underline= answer based on exhibit content.

Recall Questions - Section #1

Instructions:

Answer each of the following questions the best you can. There is only one correct answer for each question. Do NOT return to a question once you have answered it.

Mark your answer to the following questions on the score sheet provided. Make sure that you carefully match the question number with the score sheet answer section.

DO NOT MAKE ANY MARKS ON THIS TEST.

BEGIN HERE:

1.O. When a coral encrusts an abandoned snail shell which is subsequently inhabited by a hermit crab and both species benefit, the relationship is known as

1. parasitism
2. commensalism
3. <u>symbiosis</u>
4. colonialism

2.G. The Ice Age began

1. <u>about 2.5 million years ago and ended 1.6 million years ago</u>
2. about 5.0 million years ago and ended 10,000 years ago
3. about 1.0 million years ago and ended 5,000 years ago
4. about 10.0 million years ago and ended 4.0 million years ago

3.Z. Fossils that are commonly found in Gainesville's creek beds are those of the

1. *Thinobadistes segnis* (ground sloth)
2. <u>*Metaxytherium floridanum* (sea cow)</u>
3. *Gavialosuchus americanus* (narrow snouted crocodile)
4. *Barbourofelis lovei* (false sabrecat)

4.G. In Florida, fossils are commonly found in deposits of

1. granite, calcium and sandstone
2. <u>clay, phosphate and limestone</u>
3. sand, limestone and lava
4. none of the above

5.O. Specimens of which of the following plants are very rare in the fossil record

1. <u>seagrasses</u>
2. flowering plants
3. ferns
4. conifers

6.G. Dinosaur deposits can be found in rock formations of

1. <u>Georgia and Alabama</u>
2. Florida and Georgia
3. Alabama and Florida
4. Georgia and Mississippi

7.G. Bones cemented in a hard matrix are known as

1. gastroliths
2. amber
3. agate
4. <u>breccia</u>

8.G. The exhibit that displays the 5 mounted skeletons depicts animals that lived in Florida

1. <u>7-9 million years ago</u>
2. 10-15 million years ago
3. 10,000 years ago
4. 50,000 years ago

9.G. The Age of the Dinosaurs is known as the

1. <u>Mesozoic Era</u>
2. Cenozoic Era
3. Paleozoic Era
4. Precambrian Era

10.O. Which of the following is a model hanging from the ceiling?

1. *Thinobadistes segnis* (ground sloth)
2. *Cacharodon megalodon* (extinct white shark)
3. *Gavialosuchus americanus* (narrow-snouted crocodile)
4. <u>*Aturia alabamensis* (extinct nautiloid)</u>

11.Z. Primitive fossil whales were derived from

1. <u>predatory land mammals</u>
2. predatory aquatic mammals
3. predatory aquatic reptiles
4. predatory land reptiles

12.O. Fossils help us learn about

1. our environment
2. <u>the diversity of plants and animals</u>
3. floods and glaciers
4. ancient rocks

13.Z. An animal that is distantly related to a living South American animal is known as

1. <u>*Thinobadistes segnis* (ground sloth)</u>
2. *Pseudoceras* (undescribed new species)
3. *Teleoceras proterum* (rhinoceros)
4. *Geochelone hayi* (land tortoise)
5. *Barbourofelis lovei* (false sabrecat)

14.O. The predominant land plants at the beginning of the Age of Dinosaurs were

1. flowering plants
2. <u>ferns, seed ferns and horsetails</u>
3. flowering plants and ferns
4. flowering plants and horsetails

15.Z. The smallest of the following animals is

1. <u>*Pseudoceras* (undescribed new species)</u>
2. *Thinobadistes segnis* (ground sloth)
3. *Barbourofelis lovei* (false sabrecat)
4. *Teleoceras proterum* (rhinoceros)
5. *Geochelone hayi* (land tortoise)

16.G. During the Ice Ages water froze and built up at the poles thus causing

1. sea levels to rise
2. sea levels to remain normal
3. <u>sea levels to fall</u>
4. sea levels to minimally rise and fall

17.O. The oldest known insect fossils in the Caribbean are found in
1. cave breccia from the Dominican Republic
2. amber from Jamaica
3. cave breccia from Costa Rica
4. amber from the Dominican Republic

18.O. The study of the remains of humans and their cultures is known as
1. archaeology
2. paleontology
3. entomology
4. zooarchaeology

19.G. The exhibit containing the large number of disarticulated fossilized rhinoceros bones depicts fossils that were buried in
1. desert sand
2. swamp mud
3. volcanic ash
4. organic peat

20.Z. Catastrophic mass death is best exemplified by which exhibit
1. the dinosaur exhibit
2. the shellbed exhibit
3. the rhino bed exhibit
4. the forest exhibit

21.O. The hardened resin of ancient trees is known as
1. cave breccia
2. gastroliths
3. amber
4. agate

22.G. The most recent geologic time period is the
1. Paleocene
2. Miocene
3. Eocene
4. Holocene

23.Z. Fossils of the following species are not found in Florida
1. *Thinobadistes segnis* (ground sloth)
2. *Tyrannosaurus rex* (T. rex)
3. *Charcharodon megalodon* (extinct white shark)
4. *Parahippus leonensis* (extinct horse)

24.Z. **Horses evolved in**
1. Europe
2. South America
3. <u>North America</u>
4. Asia

25.Z. *Menoceras cooki* is
1. <u>an ancient small species of rhinoceros</u>
2. an ancient small species of horse
3. an ancient small species of deer
4. an ancient small species of tortoise

26.G. At the end of the Cretaceous Period - 65 million years ago - the following occurred
1. volcanic eruptions
2. <u>the last dinosaurs became extinct</u>
3. the end of the Ice Age
4. the first mammals appeared

27.G. The present to 10,000 years ago is represented by the
1. Pleistocene
2. Pliocene
3. Miocene
4. <u>Holocene</u>

28.G. During the Pliocene Epoch, Florida's
1. climates were severe and sea levels were lower than today
2. climates were mild and sea levels were lower than today
3. <u>climates were mild and sea levels were higher than today</u>
4. climates were severe and sea levels were higher than today

29.G. **Fossils are formed when tiny spaces in buried bones are filled with**
1. water
2. air
3. soil
4. <u>minerals</u>

30.G. Fossils can only be readily found in Florida in surface exposures which span the past
1. 15 million years
2. <u>50 million years</u>
3. 75 million years
4. 100 million years

31.G. Fossils of ancient ocean dwelling animals indicate that in Florida
1. the ancient coastlines are the same as the those of today
2. the ancient coastlines were further out into today's oceans
3. the ancient coastlines are not represented
<u>4. the ancient coastlines were far inland from those of today</u>

32.G. The Fossil Study Exhibit depicts life in Florida during the
1. Mesozoic Epoch
<u>2. Cenozoic Epoch</u>
3. Paleozoic Epoch
4. Precambrian Epoch

33.O. Florida's oldest vertebrate fossil was recovered
1. from the bottom of lake Okechobee
2. during a mining operation
<u>3. during an oil drilling operation</u>
4. from the bottom of lake Lochloosa

34.G. What did Florida look like 50 million years ago?
1. The entire state was a peninsula.
<u>2. The entire state was under a warm, shallow, tropical sea.</u>
3. The entire state was under a cold, shallow, subtropical sea.
4. The entire state was a tropical island.

35.Z. The fauna found in Florida during the Miocene moved in from
1. the east
<u>2. the west</u>
3. the south
4. the north

36.Z. Fossils are
1. the remains of ancient animals
2. the remains of ancient dinosaurs
<u>3. the remains of ancient animals and plants</u>
4. the remains of ancient plants

37.Z. A species that survived the extinctions of the Pliocene and Pleistocene to flourish in coastal habitats around Florida today is the
<u>1. *Busycyon contrarium* (lightning whelk)</u>
2. *Cassis floridensis* (helmet shell snail)
3. *Eoceratoconcha weisbordi* (barnacle)
4. *Mercenaria campechiensis* (quahog clam)

38.Z. Coprolites are fossilized excrement that
1. provide clues about ancient animal living habits
2. provide clues about ancient animal locomotion
3. provide clues about ancient animal reproduction
<u>4.</u> <u>provide clues about ancient animal diets</u>

39.G. Over thousands or millions of years, layers of sediment build up and
1. with time and erosion turn the bottom layers into rock
<u>2.</u> <u>with time and pressure turn the bottom layers into rock</u>
3. with pressure and water turn the bottom layers into rock
4. with air and water turn the bottom layers into rock

40.Z. Primitive sea cows feed primarily on
1. fishes
2. algae
3. crustaceans
<u>4.</u> <u>seagrasses</u>

41.Z. *Parahippus leonesis* (an early three-toed horse) was adapted for walking on
1. sand and dry ground
2. matted vegetation and grass
3. rock and icy ground
<u>4.</u> <u>matted vegetation and wet ground</u>

42.G. Primitive fossil whales are found in
1. terrestrial sedimentary deposits
2. riverine sedimentary deposits
<u>3.</u> <u>marine sedimentary deposits</u>
4. none of the above

43.G. The oldest geologic time is the
1. Cenozoic
<u>2.</u> <u>Precambrian</u>
3. Mesozoic
4. Paleozoic

44.G. Climate has varied dynamically throughout geologic history due to
1. changes associated with the orbit of the moon
<u>2.</u> <u>changes associated with the orbit of the earth</u>
3. changes associated with the sun
4. changes associated with volcanic action

45.Z. Ancient sea cows are related to today's
1. manatees
2. whales
3. dolphins
4. dugongs

46.Z. An animal that has powerful forelimbs and weaker hindlimbs most likely
1. ran to capture prey
2. ambushed its prey
3. swam to capture its prey
4. did not capture prey

47.Z. A species that swims by means of a water jet and uses gas filled chambers for buoyancy is
1. an ancient whale
2. an ancient manatee
3. an ancient nautilus
4. an ancient crocodile

48.O. The best known 18 million-year-old vertebrate fossil site in the Eastern United States was once
1. a large island
2. a lake
3. a large sinkhole
4. a swamp

49.G. The Miocene began
1. approximately 50 million years ago
2. approximately 37 million years ago
3. approximately 24 million years ago
4. approximately 10 million years ago

50.O. Archaeoceti means
1. ancient whale
2. ancient dolphin
3. fossil whale
4. fossil dolphin

51.Z. The narrow-snouted crocodile lived in
1. shallow marine and estuarine environments
2. shallow lakes and swamps
3. shallow riverine and estuarine environments
4. shallow rivers and swamps

52.Z. The habits of the extinct rhinoceros (*Teleoceras proterum*) best resemble today's
1. rhinoceros
2. elephant
3. horse
4. <u>hippopotamus</u>

53.Z. The oldest vertebrate fossil found in Florida was
1. a partial skeleton of a sea cow
2. a partial skeleton of a deer
3. a partial skeleton of a dinosaur
4. <u>a partial skeleton of a sea turtle</u>

54.Z. Dinosaurs were most closely related to
1. fish and crocodiles
2. birds and mammals
3. crocodiles and mammals
4. <u>birds and crocodiles</u>

55.G. Florida fossil bearing rock layers were first deposited
1. <u>15 million years after dinosaurs became extinct</u>
2. 100 million years before dinosaurs became extinct
3. 10 million years before dinosaurs became extinct
4. 50 million years after dinosaurs became extinct

56.Z. The largest of the following animals is
1. *Pseudoceras* (undescribed new species)
2. <u>*Thinobadistes segnis* (ground sloth)</u>
3. *Barbourofelis lovei* (false sabrecat)
4. *Teleoceras proterum* (rhinoceros)
5. *Geochelone hayi* (land tortoise)

57.O. During the second half of the Miocene, Florida was primarily covered by
1. water
2. forest
3. <u>grasslands</u>
4. desert

58.G. The Pleistocene was approximately
1. 1.6 million to 5.0 million years ago
2. -5.0 million to 24.0 million years ago
3. <u>10,000 to 1.6 million years ago</u>
4. present to 10,000 years ago

59.G. The last dinosaurs became extinct at the end of the Cretaceous Period which was

1. 150 million years ago
2. 80 million years ago
<u>3.</u> <u>65 million years ago</u>
4. 45 million years ago

60.Z. Rounded pebbles believed to have aided in dinosaur digestion are known as

1. cave breccia
<u>2.</u> <u>gastroliths</u>
3. amber
4. agate

61.G. **During the Mesozoic, Florida was**

1. an island
2. a peninsula
<u>3.</u> <u>underwater</u>
4. a continent

62.Z. **Dinosaurs were**

1. prehistoric mammals
2. prehistoric fish
3. prehistoric amphibians
<u>4.</u> <u>prehistoric reptiles</u>

63.G. **In order for a fossil to form, an animal must be buried**

1. slowly
<u>2.</u> <u>rapidly</u>
3. not at all

64.O. Each reconstructed skeleton in the exhibit has

1. a full size version of what the animal would look like with muscle and skin
<u>2.</u> <u>a scale model that shows what the animal most likely looked like</u>
3. no scale model present with any of the skeletons
4. a scale model that shows the color and the real appearance of the animal

65.Z. *Basilosaurus cetoides* was a

1. large dinosaur
2. large primitive rhinoceros
3. large primitive whale
4. large tortoise

66.G. Amber is

1. a fossilized stone
2. a hardened resin
3. a hardened sand
4. a fossilized lava

67.G. **Which of the following statements is correct**

1. Fossil dinosaurs are found in Cretaceous deposits in Florida.
2. Fossil dinosaurs are found in Carboniferous deposits in Florida.
3. Fossil dinosaurs are not found in rock deposits of Florida.
4. Fossil Dinosaurs are found in rock deposits of Florida.

68.Z. Ancient large land tortoises became extinct

1. at the end of the Pleistocene
2. at the end of the Miocene
3. at the beginning of the Oligocene
4. at the beginning of the Paleocene

69.O. The Florida Museum of Natural History has the only mounted skeleton in existence of

1. *Geochelone hayi* (land tortoise)
2. *Pseudoceras* (undescribed new species)
3. *Thinobadistes segnis* (ground sloth)
4. *Barbourofelis lovei* (false sabrecat)
5. *Teleoceras proterum* (rhinoceros)

70.Z. Male *Pseudoceras* lacked horns so they developed

1. sophisticated vocalizations to gain social status
2. special body markings to gain social status
3. sharp canine teeth to gain social status
4. sharp hooves to gain social status

71.Z. An animal that fed by walking on its hind feet and grasping branches with its front feet was known as

1. *Pseudoceras* (undescribed new species)
2. *Barbourofelis lovei* (false sabrecat)
3. *Teleoceras proterum* (rhinoceros)
4. <u>*Thinobadistes segnis* (ground sloth)</u>
5. *Geochelone hayi* (land tortoise)

72.Z. **The study of the remains of ancient animals is known as**

1. archaeology
2. <u>paleontology</u>
3. entomology
4. zooarchaeology

73.O. **During the second half of the Miocene, environmental conditions became**

1. hotter and drier
2. <u>cooler and drier</u>
3. hotter and wetter
4. cooler and wetter

74.G. The Shell Pit exhibit depicts the results of which of the following present day activities

1. construction in southern Florida
2. dredging in southern Florida
3. <u>mining in southern Florida</u>
4. forestry in southern Florida

75.Z. Ancient large land tortoises existed in Florida indicating that

1. the winter climate in Florida was cooler than today's
2. the winter climate in Florida was wetter than today's
3. <u>the winter climate in Florida was warmer than today's</u>
4. the winter climate was the same as today's

APPENDIX L
SUBJECT BACKGROUND SURVEY

The following information is being requested so the results of this study can be better analyzed.

Please, mark your answer to the following questions on the score sheet provided. Make sure that you carefully match the question number with the score sheet answer section.

<u>FIRST</u> - Enter your identification number that was given to you in the SOCIAL SECURITY NO. boxes.

<u>SECOND</u> - Place a **0** in the first box of the SECTION area.

<u>BEGIN ANSWERING</u>:

1. How many times have you visited the Florida Museum of Natural History in the past year?

   1. 0 times
   2. 1-2 times
   3. 3-5 times
   4. more than 5 times

2. When was your last visit to the Florida Museum of Natural History?

   1. 1 week ago
   2. between 1 week and 1 month ago
   3. between 1 month and 6 months ago
   4. over 6 months ago
   5. never visited this museum

3. Have you visited any OTHER natural history museums in the last year?
   1. YES
   2. NO

4. When was your last visit to any museum?
   1. 1 week ago
   2. between 1 week and 1 month ago
   3. between 1 month and 6 months ago
   4. over 6 months ago
   5. never visited any other museum

5. I prefer to visit
   1. art museums
   2. history museums
   3. science museums
   4. childrens museums
   5. no museums

6. Have you visited or attended any museum, class presentation, or other activities related to fossils in the last year?
   1. YES
   2. NO

7. What is your major area of study?
   1. SCIENCE (any)
   2. MATH
   3. EDUCATION (all levels)
   4. ENGLISH
   5. OTHER

8. What is your standing as a student?
   1. FRESHMAN/SOPHOMORE STUDENT
   2. JUNIOR/SENIOR STUDENT
   3. GRADUATE STUDENT
   4. OTHER

9. What is your gender?
   1. MALE
   2. FEMALE

10. Which of the following best describes your age?
    1. 17-21
    2. 22-25
    3. 26-35
    4. 36-45
    5. over 45

11. Which of the following best describes your ethnic or racial identity?
    1. African American/Black
    2. Hispanic
    3. Asian/Pacific Islander
    4. White
    5. Other

APPENDIX M
AFFECTIVE INSTRUMENT

Opinions - Section #2

Instructions:

Using the scale below please mark on the answer sheet the number most closely associated with your opinion. There is no right or wrong answer.

Example: I like ice cream.

Response: If you **strongly agree** with the statement darken in **#5** on the answer sheet

Again, mark your answer to the following questions on the score sheet provided. Make sure that you carefully match the question number with the score sheet answer section.

Use this scale for you answers:

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
1	2	3	4	5

DO NOT MAKE ANY MARKS ON THIS TEST.

BEGIN HERE:

1) My parents took me to museums as a child.

2) Fossils are interesting to look at.

3) I learned a great deal of information about ancient life in Florida from this fossil exhibit.

4) I knew a lot about fossils before I came to this exhibit.

5) Science principles in exhibits will always be true.

6) Dinosaur fossils are more interesting than other fossils.

7) Museums are important places for learning about science.

8) Knowledge about Florida's fossil history is important.

9) Compared to learning from texts, learning from museum exhibits is difficult.

10) Knowledge we gain from fossils never changes.

11) The Florida fossil exhibit is boring.

12) I feel I know a lot about fossils after visiting the fossil exhibit.

13) I want to know more about fossils.

14) My main reason for going to a museum is to be entertained.

15) I enjoyed reading the texts in the fossil exhibit.

16) My main reason for going to museums is for social (family and friends) outings.

17) Science principles in textbooks will always be true.

18) Knowledge about Florida's fossil history helps me understand the world around me.

19) I would rather learn from texts than from museum exhibits.

20) When understanding new ideas, memorizing facts is better than trying to understand complicated material.

21) The fossils in the Florida fossil exhibit were the most interesting aspect of the exhibit.

22) The orientation information I received for this study helped me understand the fossil exhibit.

23) I would not like to visit fossil exhibits in other museums.

24) Learning in museums is easier than learning from texts.

25) My main reason for going to a museum is to learn.

APPENDIX N
REGRESSION ANALYSIS RESULTS--SAS PRINTOUT

Zoology–full model regression

Model: MODEL1
Dependent Variable: Y1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	24	1229.61006	51.23375	5.309	0.0001
Error	143	1380.00898	9.65041		
C Total	167	2609.61905			

Root MSE	3.10651	R-square	0.4712
Dep Mean	17.61905	Adj R-sq	0.3824
C.V.	17.63155		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.023953	3.23384766	0.935	0.3513
X1	1	0.265442	0.11730350	2.263	0.0252
X2	1	0.335073	0.12529734	2.674	0.0084
X3	1	0.184719	0.08196544	2.254	0.0257
X4	1	-0.316343	0.73609831	-0.430	0.6680
X5	1	9.873486	3.95718096	2.495	0.0137
X6	1	2.684099	4.54860699	0.590	0.5561
X7	1	4.171676	4.45499915	0.936	0.3506
PR4	1	-0.151253	0.16137731	-0.937	0.3502
PR5	1	-0.206276	0.20421403	-1.010	0.3142
PR6	1	-0.086607	0.12364088	-0.700	0.4848
PR8	1	-0.052037	0.16411729	-0.317	0.7517
PR9	1	-0.021703	0.20136180	-0.108	0.9143
PR10	1	-0.119274	0.10892288	-1.095	0.2753
PR12	1	-0.097512	0.16380281	-0.595	0.5526
PR13	1	-0.124304	0.19739427	-0.630	0.5299
PR14	1	-0.036774	0.12047029	-0.305	0.7606
PR16	1	-8.122989	6.07234148	-1.338	0.1831
PR17	1	-6.096982	6.23850192	-0.977	0.3301
PR18	1	0.272378	0.21983052	1.239	0.2174
PR19	1	-0.125823	0.32927897	-0.382	0.7029
PR20	1	0.124029	0.17922330	0.692	0.4900
PR22	1	0.132810	0.23421897	0.567	0.5716
PR23	1	0.056867	0.28999448	0.196	0.8448
PR24	1	0.131364	0.17214587	0.763	0.4467

Geology--full model regression

Model: MODEL1
Dependent Variable: Y2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	24	945.63305	39.40138	4.608	0.0001
Error	143	1222.84314	8.55135		
C Total	167	2168.47619			

Root MSE	2.92427	R-square	0.4361
Dep Mean	17.90476	Adj R-sq	0.3414
C.V.	16.33235		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.065382	3.04413547	-0.021	0.9829
X1	1	0.385754	0.11042194	3.493	0.0006
X2	1	0.174502	0.11794682	1.479	0.1412
X3	1	0.239275	0.07715697	3.101	0.0023
X4	1	0.629954	0.69291544	0.909	0.3648
X5	1	12.682914	3.72503475	3.405	0.0009
X6	1	9.477782	4.28176505	2.214	0.0284
X7	1	15.067857	4.19364866	3.593	0.0004
PR4	1	-0.306779	0.15191018	-2.019	0.0453
PR5	1	-0.177743	0.19223391	-0.925	0.3567
PR6	1	-0.074535	0.11638754	-0.640	0.5229
PR8	1	-0.167426	0.15448942	-1.084	0.2803
PR9	1	-0.115984	0.18954900	-0.612	0.5416
PR10	1	-0.147733	0.10253297	-1.441	0.1518
PR12	1	-0.422432	0.15419339	-2.740	0.0069
PR13	1	-0.009360	0.18581423	-0.050	0.9599
PR14	1	-0.167983	0.11340295	-1.481	0.1407
PR16	1	-14.179358	5.71611035	-2.481	0.0143
PR17	1	-16.949731	5.87252307	-2.886	0.0045
PR18	1	0.546762	0.20693427	2.642	0.0092
PR19	1	-0.416774	0.30996197	-1.345	0.1809
PR20	1	0.258410	0.16870924	1.532	0.1278
PR22	1	0.499161	0.22047862	2.264	0.0251
PR23	1	0.176469	0.27298209	0.646	0.5190
PR24	1	0.082673	0.16204701	0.510	0.6107

Other--full model regression

Model: MODEL1
Dependent Variable: Y3

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	24	385.18039	16.04918	3.180	0.0001
Error	143	721.81366	5.04765		
C Total	167	1106.99405			

Root MSE	2.24670	R-square	0.3480
Dep Mean	9.32738	Adj R-sq	0.2385
C.V.	24.08712		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	1.101058	2.33878957	0.471	0.6385
X1	1	0.161768	0.08483646	1.907	0.0585
X2	1	0.153530	0.09061778	1.694	0.0924
X3	1	0.079301	0.05927920	1.338	0.1831
X4	1	-0.118331	0.53236245	-0.222	0.8244
X5	1	4.280217	2.86192008	1.496	0.1370
X6	1	1.984516	3.28965236	0.603	0.5473
X7	1	1.109628	3.22195311	0.344	0.7311
PR4	1	-0.042962	0.11671161	-0.368	0.7133
PR5	1	-0.300885	0.14769207	-2.037	0.0435
PR6	1	0.082964	0.08941980	0.928	0.3551
PR8	1	-0.062402	0.11869322	-0.526	0.5999
PR9	1	-0.013636	0.14562927	-0.094	0.9255
PR10	1	0.028398	0.07877542	0.360	0.7190
PR12	1	-0.028882	0.11846579	-0.244	0.8077
PR13	1	0.022934	0.14275987	0.161	0.8726
PR14	1	-0.023049	0.08712676	-0.265	0.7917
PR16	1	-1.121881	4.39165057	-0.255	0.7987
PR17	1	0.901592	4.51182144	0.200	0.8419
PR18	1	0.025025	0.15898626	0.157	0.8751
PR19	1	0.049331	0.23814178	0.207	0.8362
PR20	1	-0.041931	0.12961822	-0.323	0.7468
PR22	1	-0.008275	0.16939230	-0.049	0.9611
PR23	1	-0.021225	0.20973037	-0.101	0.9195
PR24	1	-0.050338	0.12449967	-0.404	0.6866

Mainpoints--full model regression

Model: MODEL1
Dependent Variable: Y4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	24	398.75961	16.61498	3.349	0.0001
Error	143	709.52015	4.96168		
C Total	167	1108.27976			

Root MSE	2.22748	R-square	0.3598
Dep Mean	13.35119	Adj R-sq	0.2524
C.V.	16.68378		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	5.347328	2.31878760	2.306	0.0225
X1	1	0.109332	0.08411092	1.300	0.1957
X2	1	0.161274	0.08984279	1.795	0.0748
X3	1	0.136271	0.05877223	2.319	0.0218
X4	1	-0.083015	0.52780954	-0.157	0.8752
X5	1	5.874006	2.83744414	2.070	0.0402
X6	1	-1.871937	3.26151834	-0.574	0.5669
X7	1	5.761579	3.19439808	1.804	0.0734
PR4	1	-0.133803	0.11571346	-1.156	0.2495
PR5	1	-0.290438	0.14642897	-1.983	0.0492
PR6	1	0.055372	0.08865505	0.625	0.5332
PR8	1	0.079395	0.11767812	0.675	0.5010
PR9	1	0.073408	0.14438381	0.508	0.6119
PR10	1	-0.057045	0.07810171	-0.730	0.4663
PR12	1	-0.132257	0.11745263	-1.126	0.2620
PR13	1	-0.123030	0.14153895	-0.869	0.3862
PR14	1	-0.028692	0.08638162	-0.332	0.7403
PR16	1	-6.399528	4.35409196	-1.470	0.1438
PR17	1	-1.288441	4.47323510	-0.288	0.7737
PR18	1	0.360480	0.15762656	2.287	0.0237
PR19	1	0.056536	0.23610512	0.239	0.8111
PR20	1	-0.114007	0.12850969	-0.887	0.3765
PR22	1	0.103681	0.16794361	0.617	0.5380
PR23	1	0.008297	0.20793670	0.040	0.9682
PR24	1	-0.042294	0.12343492	-0.343	0.7324

Total--full model regression

Model: MODEL1
Dependent Variable: Y5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	24	6516.67559	271.52815	6.364	0.0001
Error	143	6101.30061	42.66644		
C Total	167	12617.97619			

Root MSE	6.53196	R-square	0.5165
Dep Mean	44.84524	Adj R-sq	0.4353
C.V.	14.56555		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	4.297495	6.79970094	0.632	0.5284
X1	1	0.809480	0.24665005	3.282	0.0013
X2	1	0.653827	0.26345842	2.482	0.0142
X3	1	0.498772	0.17234593	2.894	0.0044
X4	1	0.222160	1.54776876	0.144	0.8861
X5	1	26.595284	8.32062913	3.196	0.0017
X6	1	13.921958	9.56420043	1.456	0.1477
X7	1	20.363549	9.36737442	2.174	0.0314
PR4	1	-0.497214	0.33932255	-1.465	0.1450
PR5	1	-0.675708	0.42939387	-1.574	0.1178
PR6	1	-0.073961	0.25997545	-0.284	0.7764
PR8	1	-0.278826	0.34508381	-0.808	0.4204
PR9	1	-0.142300	0.42339658	-0.336	0.7373
PR10	1	-0.234140	0.22902843	-1.022	0.3084
PR12	1	-0.537366	0.34442257	-1.560	0.1209
PR13	1	-0.111475	0.41505419	-0.269	0.7886
PR14	1	-0.235951	0.25330876	-0.931	0.3532
PR16	1	-23.386631	12.76810486	-1.832	0.0691
PR17	1	-22.170161	13.11748474	-1.690	0.0932
PR18	1	0.818439	0.46223013	1.771	0.0788
PR19	1	-0.492601	0.69236364	-0.711	0.4779
PR20	1	0.358484	0.37684670	0.951	0.3431
PR22	1	0.612675	0.49248422	1.244	0.2155
PR23	1	0.212591	0.60976149	0.349	0.7279
PR24	1	0.171977	0.36196524	0.475	0.6354

Recall Zoology--full model regression

Model: MODEL1
Dependent Variable: Y6

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	24	9329.66121	388.73588	1.677	0.0339
Error	143	33143.33284	231.77156		
C Total	167	42472.99405			

Root MSE	15.22405	R-square	0.2197
Dep Mean	22.00595	Adj R-sq	0.0887
C.V.	69.18149		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-3.589154	15.84808128	-0.226	0.8212
X1	1	0.998233	0.57486794	1.736	0.0846
X2	1	-0.304008	0.61404326	-0.495	0.6213
X3	1	-0.015419	0.40168712	-0.038	0.9694
X4	1	-3.966427	3.60738882	-1.100	0.2734
X5	1	23.351468	19.39291270	1.204	0.2305
X6	1	-16.099429	22.29130769	-0.722	0.4713
X7	1	33.864871	21.83256477	1.551	0.1231
PR4	1	-0.614040	0.79085999	-0.776	0.4388
PR5	1	-0.433863	1.00078945	-0.434	0.6653
PR6	1	0.402000	0.60592548	0.663	0.5081
PR8	1	-0.111623	0.80428776	-0.139	0.8898
PR9	1	1.553797	0.98681154	1.575	0.1176
PR10	1	0.190312	0.53379717	0.357	0.7220
PR12	1	-1.506452	0.80274661	-1.877	0.0626
PR13	1	1.243023	0.96736791	1.285	0.2009
PR14	1	-0.131247	0.59038741	-0.222	0.8244
PR16	1	-59.594160	29.75865638	-2.003	0.0471
PR17	1	2.967832	30.57295700	0.097	0.9228
PR18	1	1.798514	1.07732101	1.669	0.0972
PR19	1	-0.196912	1.61369380	-0.122	0.9030
PR20	1	0.135820	0.87831761	0.155	0.8773
PR22	1	0.703926	1.14783430	0.613	0.5407
PR23	1	-3.377804	1.42117274	-2.377	0.0188
PR24	1	0.250816	0.84363337	0.297	0.7667

Recall Geology--full model regression

Model: MODEL1
Dependent Variable: Y7

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	24	1187.20874	49.46703	0.827	0.6974
Error	143	8549.62459	59.78758		
C Total	167	9736.83333			

Root MSE	7.73224	R-square	0.1219
Dep Mean	11.91667	Adj R-sq	-0.0254
C.V.	64.88596		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.303529	8.04918897	0.410	0.6821
X1	1	0.066347	0.29197356	0.227	0.8206
X2	1	-0.093615	0.31187057	-0.300	0.7645
X3	1	0.308619	0.20401558	1.513	0.1326
X4	1	1.226094	1.83218106	0.669	0.5044
X5	1	2.425537	9.84959733	0.246	0.8058
X6	1	7.346237	11.32168272	0.649	0.5175
X7	1	8.080501	11.08868869	0.729	0.4674
PR4	1	0.237306	0.40167522	0.591	0.5556
PR5	1	-0.042710	0.50829771	-0.084	0.9332
PR6	1	-0.309654	0.30774758	-1.006	0.3160
PR8	1	0.016820	0.40849514	0.041	0.9672
PR9	1	-0.225128	0.50119838	-0.449	0.6540
PR10	1	-0.140747	0.27111385	-0.519	0.6045
PR12	1	-0.274254	0.40771240	-0.673	0.5022
PR13	1	0.482260	0.49132302	0.982	0.3280
PR14	1	-0.230807	0.29985585	-0.770	0.4427
PR16	1	-0.740824	15.11432485	-0.049	0.9610
PR17	1	-20.855378	15.52790549	-1.343	0.1814
PR18	1	0.298187	0.54716784	0.545	0.5866
PR19	1	-0.923284	0.81958984	-1.127	0.2618
PR20	1	0.147416	0.44609466	0.330	0.7415
PR22	1	0.858216	0.58298131	1.472	0.1432
PR23	1	0.214222	0.72180902	0.297	0.7671
PR24	1	-0.289472	0.42847865	-0.676	0.5004

Recall Other (Y8)--full model regression

Model: MODEL1
Dependent Variable: Y8

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	23	282.99959	12.30433	0.923	0.5687
Error	144	1920.40517	13.33615		
C Total	167	2203.40476			

Root MSE	3.65187	R-square	0.1284
Dep Mean	3.44048	Adj R-sq	-0.0108
C.V.	106.14429		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.456291	3.49095046	-0.131	0.8962
X1	1	0.110017	0.11847705	0.929	0.3547
X2	1	-0.091194	0.14712314	-0.620	0.5363
X3	1	0.027840	0.09529421	0.292	0.7706
X4	1	0.726266	0.85543630	0.849	0.3973
X5	1	5.569502	4.40740163	1.264	0.2084
X6	1	-2.309246	4.53099712	-0.510	0.6111
X7	1	3.332831	4.41895831	0.754	0.4520
PR4	1	-0.186518	0.17666722	-1.056	0.2928
PR5	1	0.156537	0.23997134	0.652	0.5152
PR6	1	-0.031351	0.14478410	-0.217	0.8289
PR8	1	-0.097302	0.13646089	-0.713	0.4770
PR9	1	0.307539	0.23596829	1.303	0.1946
PR10	1	0.093502	0.12534626	0.746	0.4569
PR12	1	-0.004104	0.13624679	-0.030	0.9760
PR13	1	0.037418	0.23200661	0.161	0.8721
PR14	1	-0.035842	0.13780103	-0.260	0.7952
PR16	1	-8.599767	6.57208223	-1.309	0.1928
PR17	1	4.534488	4.94973423	0.916	0.3611
PR18	1	0.071944	0.22134083	0.325	0.7456
PR19	1	0.182957	0.38699581	0.473	0.6371
PR20	1	0.017342	0.20870214	0.083	0.9339
PR23	1	-0.506530	0.34083098	-1.486	0.1394
PR24	1	-0.045985	0.18527226	-0.248	0.8043

Recall Mainpoints--full model regression

Model: MODEL1
Dependent Variable: Y9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	24	77.07421	3.21143	0.940	0.5484
Error	143	488.54483	3.41640		
C Total	167	565.61905			

Root MSE	1.84835	R-square	0.1363
Dep Mean	3.45238	Adj R-sq	-0.0087
C.V.	53.53841		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.813311	1.92411406	-0.423	0.6732
X1	1	0.140597	0.06979466	2.014	0.0458
X2	1	-0.030341	0.07455093	-0.407	0.6846
X3	1	0.028480	0.04876880	0.584	0.5602
X4	1	0.204151	0.43797274	0.466	0.6418
X5	1	2.731098	2.35449171	1.160	0.2480
X6	1	2.158235	2.70638557	0.797	0.4265
X7	1	3.393081	2.65068964	1.280	0.2026
PR4	1	0.003156	0.09601824	0.033	0.9738
PR5	1	-0.077473	0.12150575	-0.638	0.5247
PR6	1	-0.059517	0.07356536	-0.809	0.4198
PR8	1	-0.046342	0.09764850	-0.475	0.6358
PR9	1	-0.032415	0.11980870	-0.271	0.7871
PR10	1	-0.031700	0.06480826	-0.489	0.6255
PR12	1	-0.173871	0.09746139	-1.784	0.0765
PR13	1	0.119803	0.11744805	1.020	0.3094
PR14	1	0.013978	0.07167888	0.195	0.8457
PR16	1	-0.748615	3.61299567	-0.207	0.8361
PR17	1	-2.032638	3.71185984	-0.548	0.5848
PR18	1	0.019926	0.13079744	0.152	0.8791
PR19	1	-0.186942	0.19591841	-0.954	0.3416
PR20	1	0.087323	0.10663646	0.819	0.4142
PR22	1	0.136182	0.13935845	0.977	0.3301
PR23	1	-0.052949	0.17254445	-0.307	0.7594
PR24	1	-0.034883	0.10242545	-0.341	0.7339

Time--full model regression

Model: MODEL1
Dependent Variable: Y10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	24	7098.93868	295.78911	2.732	0.0001
Error	143	15484.96608	108.28648		
C Total	167	22583.90476			

Root MSE	10.40608	R-square	0.3143
Dep Mean	40.69048	Adj R-sq	0.1993
C.V.	25.57375		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	32.801917	10.83262552	3.028	0.0029
X1	1	-0.483065	0.39293899	-1.229	0.2210
X2	1	0.569367	0.41971647	1.357	0.1771
X3	1	0.610810	0.27456485	2.225	0.0277
X4	1	-5.806026	2.46575541	-2.355	0.0199
X5	1	8.880819	13.25562113	0.670	0.5040
X6	1	1.786077	15.23675859	0.117	0.9068
X7	1	2.893473	14.92319443	0.194	0.8465
PR4	1	0.247349	0.54057586	0.458	0.6480
PR5	1	-0.774946	0.68406876	-1.133	0.2592
PR6	1	0.065393	0.41416773	0.158	0.8748
PR8	1	0.634260	0.54975413	1.154	0.2505
PR9	1	0.220473	0.67451446	0.327	0.7443
PR10	1	-0.718992	0.36486593	-1.971	0.0507
PR12	1	0.664782	0.54870071	1.212	0.2277
PR13	1	-1.040605	0.66122416	-1.574	0.1178
PR14	1	-0.456637	0.40354700	-1.132	0.2597
PR16	1	-14.026666	20.34090909	-0.690	0.4916
PR17	1	-11.700370	20.89750730	-0.560	0.5764
PR18	1	0.251548	0.73638031	0.342	0.7332
PR19	1	0.229175	1.10300675	0.208	0.8357
PR20	1	0.193925	0.60035569	0.323	0.7472
PR22	1	-0.124231	0.78457820	-0.158	0.8744
PR23	1	0.360740	0.97141300	0.371	0.7109
PR24	1	0.150349	0.57664800	0.261	0.7947

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BIOGRAPHICAL SKETCH

James F. Ellis, Jr., although born in the United States in 1949 grew up in Buenos Aires, Argentina. It was here in his early years that Mr. Ellis's parents took him on many weekend excursions to the local zoos and museums. Returning stateside in 1961, Mr. Ellis finished his early years of schooling in Chicago, Illinois. Again the location is a prime one for visiting local zoos and the science and natural history museums in the area.

Following completion of high school, Mr. Ellis attended Indiana University where he received a bachelor's degree in zoology in 1971. Shortly after graduation he married Georgeann Alar of Indianapolis, Indiana. They moved to Denver, Colorado. Over the next 13 years Mr. Ellis followed a career that began in a medical research facility in Denver followed by work as a zookeeper at the Oklahoma City Zoo. It was here that he began to become involved with education through work with the Great Ape collection at the zoo. His wide range of experiences there led him to a position as assistant director of the Glen Oak Zoo in Peoria, Illinois, where he became heavily involved in the development of the zoo as a community educational resource. These experiences led to an offer of a position as the General

Curator/Professional Specialist for the Biological Parks Training Program and Teaching Zoo at Santa Fe Community College in Gainesville, Florida. During his tenure in this position he provided the technical and professional support for the redevelopment of the 7 year old zookeeper training program and the refurbishing of the 10 acre S.F.C.C. Teaching Zoo. In 1984, Mr. Ellis began pursuing a Master's degree in the Latin American area studies Tropical Conservation and Museum Studies program at the University of Florida also in Gainesville. His thesis research on "Brazilian Zoological Parks: Their Status and Conservation Potential" led him to return to South America and Brazil in particular. With support from the Amazon Research and Training Program Mr. Ellis was also able to become a consultant to the then 120-year-old Museu Paraense Emilio Goeldi, Belem, Brazil. His research and consulting activities led him over the next six years to become heavily involved in developing a master plan for the Parque Zoobotanico for the Museu. This work also led to the Brazilian National Research Council's funding of his return to Belem to work on the continued development of the visitor and educational components of the Museu. Throughout this period of time Mr. Ellis visited numerous facilities in Brazil and collected historical as well as recent information on the role of zoological parks in the worldwide conservation movement.

Mr. Ellis has also provided consulting services to the Hope Zoo and Botanical Garden, Kingston, Jamaica; Monkey Jungle, Miami, Florida; Walt Disney World's Discovery Island, Orlando, Florida; and the Florida Museum of Natural History, Gainesville, Florida. His experiences include working as a zoologist with captive management of many native and exotic species as well as endangered species (such as the Jamaican Hutia and the last remaining Florida Dusky Seaside Sparrows). Throughout his career Mr. Ellis has successfully incorporated many of his skills as a naturalist and zoologist with those of program and facility management. Additionally through his dissertation he has been able to merge these skills and his international experiences with those required to become an informal setting educator and visitor studies specialist.

Throughout his career Mr. Ellis has been heavily involved in developing an understanding of the processes by which people can be aided in learning more from zoos, museums, national parks, and other informal education facilities. These efforts have culminated in his pursuing and attaining a PhD at the University of Florida with a specialization in museum studies/science education. Mr. Ellis hopes to be employed in a facility where he can contribute to the enhancement of the visitor experience and where he might continue to provide support to institutions in developing nations.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

John J. Koran, Jr., Chair
Professor of Instruction
and Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Mary Lou Koran
Professor of Foundations
of Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

David Miller
Associate Professor of
Foundations of Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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This dissertation was submitted to the Graduate Faculty of the College of Education and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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